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Resolution in Stereoscopic Projection

By BERNARD G. SAUNDERS

The possibilities of limitation of depth effect by film's resolution are considered, along with related considerations of the matchings of camera and of projector lenses.

THE SPECTATORS relax in their seats; the stereo pictures are projected on the screen. A wonderful vista stretches out over the audience and through the theater. What is the smallest illusion of depth that one can perceive? How is this depth limited by resolution of the film's emulsion? In photographing the picture and showing it, how closely must we match the two camera lenses and the two projector lenses?

The spectator's two eyes are at e_L and e_R (see Fig. 1). Two homologous points of the scene E_L and E_R are projected on the screen with a separation κe, where κ is some fraction or multiple of the interocular distance e. By means of an occulting device, mechanical or optical, the left eye sees point E_L only and the right eye sees point E_R only. The sight-lines for the left and right eye converge at O, and, if the spectator is blessed with binocular vision, the two points E_L and E_R will fuse and appear as a single point of the scene in space at O. It is obvious from the construction that when $\kappa = -1$, the point will appear as though at infinity, and when $\kappa = +4$, the point will appear $\frac{1}{5}$ of the way out from the spectator to the projection screen.

If the point seen by the right eye is displaced a distance σ_s from E_R to E'_R, the two eyes will locate the fused point at O′, closer to or farther from the spectator, depending on whether σ_s is positive or negative.

We wish to determine how O moves to O′ with change of σ_s, that is to say, how the ratio of the depth difference, OO′, to the spectator's screen distance, d_s, is related to the very small displacement σ_s.

From the diagram, where d_o and d'_o represent the distances of the spectator to the fused points O and O′, respectively,

$$\frac{d_s - d_o}{d_o} = \frac{\kappa e}{e}, \quad d_o = \frac{1}{\kappa + 1} d_s;$$

$$\frac{d_s - d'_o}{d'_o} = \frac{\kappa e + \sigma_s}{e}, \quad d'_o = \frac{1}{\kappa + \frac{\sigma_s}{e} + 1} d_s.$$

Since the depth displacement of O is equal to $d_o - d'_o$,

$$\frac{d_o - d'_o}{d_s} = \frac{\sigma_s/e}{(\kappa + 1)\left(\kappa + \frac{\sigma_s}{e} + 1\right)} \quad (1)$$

A contribution submitted on April 9, 1953, by Bernard G. Saunders, 100 Plymouth Circle, Oak Ridge, Tenn.

We see that the minimum relative depth that can be perceived in projection can be expressed as a function of the minimum perceptible displacement σ_s on the screen.

Binocular Resolution

What is the minimum relative depth that can be perceived under ordinary circumstances? In Fig. 1, the two eyes subtend an angle α with point O and an angle β with point O′. The difference in the two angles is called the binocular parallax difference. Experience shows that the minimum b.p.d. detectable by the average unaided eyes is about 30 sec of arc. We can therefore write

$$\beta - \alpha = 30 \text{ sec} = 0.00015 \text{ radian.}$$

From the figure, σ_s subtends the angle

$$E_R e_R E'_R = (90° - \alpha) - (90° - \beta) = \beta - \alpha.$$

Since σ_s and κe are small compared to d_s, we also have the relation

$$\sigma_s = (\beta - \alpha) d_s,$$

or

$$\sigma_s = 1.5 \times 10^{-4} d_s. \qquad (2)$$

This means that if the point E_R moves to E'_R, a distance σ_s equal to or greater than $1.5 \times 10^{-4}\, d_s$, a spectator viewing the screen at a distance d_s will be aware of a depth displacement OO′.

When σ_s is a small fraction of e, which is the case in this discussion, Eq. 1 for the relative depth displacement reduces to

$$\frac{d_o - d'_o}{d_s} = \frac{\sigma_s/e}{(\kappa + 1)^2}.$$

Substituting for σ_s,

$$\frac{d_o - d'_o}{d_s} = \frac{1.5 \times 10^{-4}}{e(\kappa + 1)^2}\, d_s.$$

Suppose, for example, the spectator sees point O as lying in the plane of the screen, or $\kappa = 0$. Taking e = 2.5 in.,

$$\frac{d_o - d'_o}{d_s} = 6 \times 10^{-5} d_s.$$

The absolute depth displacement will be

$$d_o - d'_o = 6 \times 10^{-5} d_s^2.$$

For a screen distance d_s = 50 ft from the spectator,

$$d_o - d'_o = 21.6 \text{ in.}$$

As another example, suppose the point of convergence O lies half-way between the spectator and the screen, i.e., $\kappa = 1$; then,

$$d_o - d'_o = 5.4 \text{ in.}$$

In terms of σ_s,

$$\sigma_s = 1.5 \times 10^{-4} d_s = 0.09 \text{ in.}$$

for a screen distance of 50 ft. A point must be displaced 0.09 in. on the screen to show any displacement in space. The fused image will then be displaced 21.6 in. when located at the screen and 5.4 in. when located midway. If the right and left views of a stereoscopic picture are projected on a screen and they differ in width by so much as one-tenth inch, the eyes at a distance of fifty feet will interpret the difference as due to one side of the fused picture being closer to the screen.

It should be observed here that the eyes can resolve or distinguish between two points on the screen when they subtend an angle with the spectator of approximately one minute. For a screen distance of 50 ft, this corresponds to a separation σ_s of $2.9 \times 10^{-4} \times 600 = 0.17$ in., or twice the separation required to resolve two points in depth. It is a well-known fact that one possesses vernier acuity leading to binocular resolution long after the ability to distinguish line detail has vanished.*

Film Resolution

We have let σ_s represent the disparity in widths of the right- and left-eye images on the screen. In terms of disparity on

* Donald H. Jacobs, *Fundamentals of Optical Engineering*, McGraw-Hill Book Co., 1943.

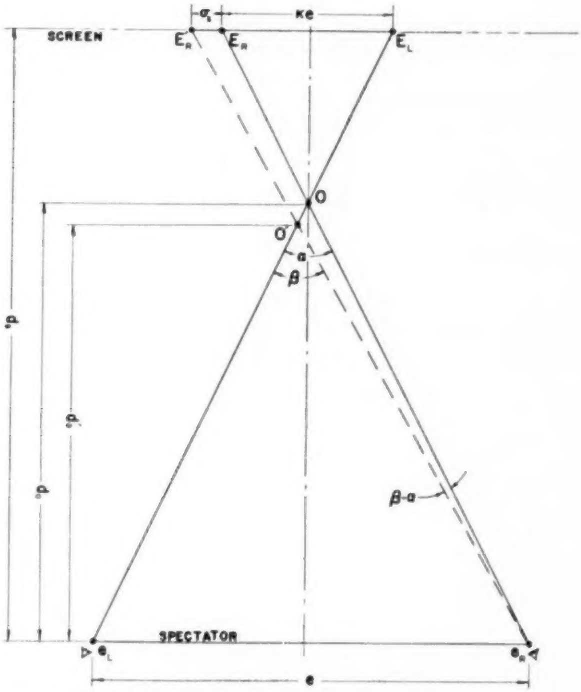

Fig. 1. Relationship between depth content and image disparity.

e_L = position of left eye
e_R = position of right eye
e = interocular distance
E_L = any point of the left-eye view as projected on the screen
E_R = homologous point of the right-eye view
κe = separation between E_L and E_R
O = position of the point corresponding to the binocular fusion of E_L and E_R
O′ = new position of point O when E_R is displaced to E'_R
σ_s = displacement E_R to E'_R
d_0-d_0' = depth displacement of O, denoted by its approximate equivalent OO′
α = angle of convergence for point O
β = angle of convergence for point O′

the film, σ_f, if M is the screen magnification,

$$\sigma_f = \frac{\sigma_s}{M} = 1.5 \times 10^{-4} \frac{d_s}{M} \cdot \qquad (3)$$

Two images on the film that differ in width by σ_f or greater will show a depth displacement.

For d_s = 600 in., M = 300,

$$\sigma_f = 3 \times 10^{-4} \text{ in.}$$

Suppose the film resolves 50 lines/mm. This corresponds to 7.9×10^{-5} in. From the conditions stated, it is apparent that although the resolving power of the emulsion is on the borderline it is not a

limiting factor in producing stereoscopic images with maximum binocular resolution.

In any case, σ_f must be equal to or greater than the limit of resolution of the emulsion, or

$$\sigma_f = 1.5 \times 10^{-4} \frac{d_s}{M} \geq 7.9 \times 10^{-5},$$

$$d_s \geq 0.53M. \qquad (4)$$

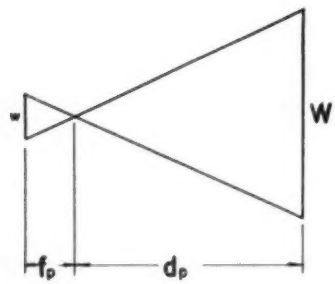

Figure 2

To press the matter further, let d_p in Fig. 2 represent the projector distance to the screen, w = width of the projector aperture, W = width of the projected image and f_p = focal length of the projection lenses. Then, as a first approximation,

$$\frac{W}{w} = \frac{d_p}{f_p} = M. \qquad (5)$$

∴ from Eq. 4,

$$d_s \geq \frac{0.53}{f_p} d_p.$$

This means that in the projection of stereo pictures, where the resolution of the film is 50 lines/mm, no advantage in binocular resolution is gained by sitting closer to the screen than $0.53/f_p$ the projector distance.

Lens Matching

A. Projection Lenses. In the foregoing discussion it has been assumed that the projection lenses are identical. Since paired lenses may show some measurable difference, it is interesting to see what tolerance is permissible without impairing the construction of the plastic image

From Eq. 5 we have

$$M = \frac{d_p}{f_p},$$

or

$$\Delta M = -\frac{d_p}{f_p^2} \Delta f_p.$$

Since wM is the width of a projected aperture on the screen, wΔM is the difference in widths of the projected apertures when the focal lengths of the projection lenses differ by Δf_p.

Consequently,

$$w\Delta M = \sigma_s = -\frac{w\Delta f_p}{f_p^2} d_p.$$

By Eq. 2, the distance σ_s must not exceed $1.5 \times 10^{-4} d_s$, and therefore

$$-\frac{w}{f_p}\frac{\Delta f_p}{f_p} d_p = 1.5 \times 10^{-4} d_s,$$

or

$$-\frac{\Delta f_p}{f_p} = 1.5 \times 10^{-4} \frac{f_p}{w}\frac{d_s}{d_p}.$$

In practice, suppose we wish to determine how closely we must match projection lenses for 35mm stereo.

For f_p = 4 in. and w = 0.825 in.,

$$\frac{\Delta f_p}{f_p} = 7.3 \times 10^{-4} \frac{d_s}{d_p}.$$

As one might expect, the farther the spectator sits from the screen with respect to the projector, the less critical must be the agreement between projection lenses. If the spectator sits half-way between the projector and the screen,

$$\frac{\Delta f_p}{f_p} = 3.7 \times 10^{-4},$$

and the focal lengths of the projection lenses must match within 0.04 of 1%.

B. Camera Lenses. In matching camera lenses, which are responsible for laying down images on the film, they must be

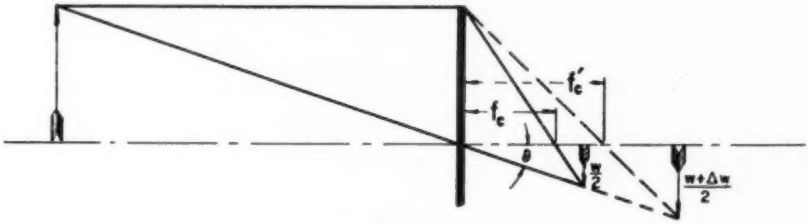

Figure 3

such that the image widths will not differ by more than that specified by Eq. 3, namely,

$$\sigma_f = 1.5 \times 10^{-4} \frac{d_s}{M}.$$

Consulting Fig. 3, we can write after disregarding 2nd order effects,

$$f_c = \frac{w}{2 \tan \theta};$$

$$\frac{\Delta f_c}{f_c} = \frac{\Delta w}{w}.$$

Substituting σ_f for its equivalent Δw, and assuming the two images are projected with identical projection lenses,

$$\frac{\Delta f_c}{f_c} = \frac{\sigma_f}{w} = 1.5 \times 10^{-4} \frac{d_s}{wM};$$

$$\frac{\Delta f_c}{f_c} = 1.5 \times 10^{-4} \frac{d_s}{W}.$$

For seats situated at a distance from the screen equal to 2.5 times the screen width, that is, $d_s = 2.5W$,

$$\frac{\Delta f_c}{f_c} = 3.75 \times 10^{-4},$$

or 0.04 of 1%.

Admittedly, the tolerances specified here are somewhat academic. J. A. Norling has looked at lens matching from a practical point of view and has quoted a figure of 0.25 of 1%. Focal-length tolerances acceptable to the industry should be tempered by other parameters influencing binocular resolution, such as lens resolution, lens distortion, shrinkage of film and registration of film in the film gate. Indeed, the average theater-goer does not necessarily possess a minimum binocular parallax difference of 30 sec of arc. Nor does he usually sit in the prescribed seats where the reconstructed image is orthostereoscopic. So many pernicious factors are involved that it is a wonder that stereo projection is as good as it is today.

REPRINT

Depth Perception

With Special Reference to Motion Pictures

By THADDEUS R. MURROUGHS

Editorial Note: This paper is reprinted from *The Journal of the American Optometric Association* of April and May 1953 not only because of its timely interest but also to give *Journal* readers a readily available reference. The bibliography of this paper shows sources of fuller treatments. Society members may recall a briefer treatment in the *Journal:* Howard T. Souther, "The illusion of depth perception in motion pictures," *Jour. SMPE,* 46: 245–253, Apr. 1946.

Since every person lives in the center of his space world, space is egocentric radiating out in all directions. The direction and distance of all external objects and events are established with reference to one's own body.

Vision is the dominant sense of space perception, and whatever we see through the eye has spatial quality. Strictly speaking, we never see space, we see only the objects which occupy or fill space; or we appreciate spatial extent in a homogeneous field lying between two objects.

Two separate objects form two simultaneous and discrete visual stimuli and since they do not occupy the same position in space we refer to their relative separation. Space cannot exist independently of objects, even though it can be treated as an abstraction (in philosophy) or as a construct of geometry.

Another subjective description covering the perception of spatial relations is a well-accepted phenomenon regarding curvature of the visual field. Einstein postulated a geometry of space which included curvature, and the subjective horopter* is a real entity of perception which shows a characteristic curvature. Neither of these should be confused with the phenomenal description of curved space which engulfs the subject.

Panoramic Vision

Lower vertebrates with eyes on the sides of the head can see in two directions simultaneously. The visual field of most fishes and birds is a full 360°, so

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* For definitions of terms marked with an asterisk see glossary at end of article.

that these forms see all aspects of space from a truly egocentric point of reference. Each eye perceives the objects in space in panoramic fashion *and in depth.* The primitive and basic responses to light perception are still present in man's peripheral field and represent the more archaic panoramic vision.

In the evolution of vertebrates up to man the eyes have migrated anteriorly so that portions of the originally monocular fields overlap. The area of the overlap gives us single binocular vision with an added advantage which is absent in panoramic vision. However, the original panoramic field has been reduced in size; in man it is 200° at the most.

It would appear that in panoramic vision the visual perception of space was originally bidimensional and restricted to the localization on objects in a flat visual field. It is an erroneous assumption that any form (fish, frog or one-eyed person) with panoramic vision sees the surrounding world as flat, like a photograph; and that judgment of distances is totally faulty. Fish open their mouths at precisely the right time to seize their prey. The Gecko lizard throws its adhesive tongue accurately at an insect and one-eyed man (Wiley Post) can land an aeroplane. The pelican not only plunges into the water to catch his fish, but has learned, without the benefit of a textbook, to make allowance for the displacement of its prey resulting from the difference of refractive index between water and air. These acts would be impossible unless depth perception were present.

Three-Dimensional Vision

The visual appreciation of depth in space involves three dimensions and the question arises of how a flat two-dimensional representation on the retina of the eye can yield a tridimensional percept. This question can be answered fairly well, but the phenomenon is no more remarkable than the ability of the organism to extract meaning from a retinal image which is vertically inverted (upside-down) and laterally reversed (mirror image).

As the visual apparatus increased in complexity of structure it also became more specialized in function. Certain areas (foveas*) generally centrally located, became areas of fixation,* enabling the organism to maintain the moving object in the center of its egocentric field. With the advent of a moving head, external eye muscles evolved to hold the eye in a stationary position relative to the object. Early eyes were immovable and the development of movable eyes, particularly in terrestrial forms, reduced the necessity of excessive head movements.

In the higher forms the psychological factor of attention became linked to fixation by the fovea; hence the visual attention reflex, which means nothing more than placing the object in the center of the visual field and attending to it. This gives us the cue to direction of the object.

Since the objective relations of objects are spatial in character, our perceptions are *fair* replicas of the spatial order, even though the retinal images are extremely unreliable in this respect. The appreciation of tridimensionality is mediated by certain specific cues to depth perception which were primarily identified by the painters of the Renaissance period, and thoroughly evaluated later by psychologists. Cinerama projection, like the former "flats," utilizes these cues, but Cinerama has added a type of panoramic vision which is lacking in the "flats." It behooves us to identify these cues before discussing the depth effects on the motion-picture screen.

The perception of depth in panoramic vision revolves around the question of the data which can be used as cues. If a normal two-eyed person closes one eye and attempts to thread a needle he may find the task difficult due to an erroneous estimate of the distances involved. However he would soon learn to rely on monocular cues, as the one-eyed person does, and except for minor discrepancies in judging distances and sizes of near objects he would get along quite well. The cues which he uses (with few exceptions) are essentially the same cues as are found in strabismic* subjects, in panoramic vision, in paintings, photographs, in Cinerama, three-dimensional movies and operating in all normal binocular individuals.

Size of Retinal Image

The size of the retinal image is one cue to depth perception. Any change in the size of familiar objects is perceived as a variation in distance from the observer. We learn to make allowances in this respect. The retinal image of a tall man and a boy may be the same, yet we judge the man to be farther away.

In motion pictures the effect of distance may be rapidly introduced by making a near scene (a building or mountain) suddenly recede into the background, which immediately reduces the size of the retinal image. But no matter how small the image appears, we know it is a large building or a mountain at a great distance. Simultaneously, hitherto unseen objects enter the boundaries of the field of vision and since they too tend to become smaller, we judge them in terms of distance.

Experimentally it is possible to introduce erroneous percepts relative to image size by removing or perverting other normal visual cues. In everyday life the size of the retinal image proves useful in the cases of familiar objects. Before one is tempted to compare the perception by analogy to a camera lens system we should not disregard the unique psychological phenomenon of size constancy.

Near objects tend to be seen smaller than they are, while distant objects appear larger subjectively than they are. This explains why a photograph of a house always appears so much smaller than when the house is perceived visually at the same distance. The projected motion-picture close-ups showing huge heads and faces are resolved into their proper settings with due allowance for the exaggerated size on the basis of size constancy.

Light and Shadow

A second cue to space perception lies in the distribution of lights and shadows. Prior to and during the Renaissance, artists were having difficulty in creating good depth effects. They also had difficulty in duplicating distances between objects as well as distance from the observer.

Leonardo da Vinci noted that to create the spatial order of objects on canvas it was necessary that the details be reproduced not as one knows them to be but as the eye sees them.

Painters must learn to reproduce the retinal images on canvas as a bidimensional presentation of a tridimensional order, duplicating as closely as possible the retinal images. Leonardo found that depth was revealed by light (brightness) and shadow.

Brightness (Light)

Of two given objects the brighter one will be judged to be closer in the absence of other cues. A lighted area is also perceived as larger than a dimly illuminated area of the same size. Attention is attracted to the brightest area in contrast situations where the surrounding visual field is selectively darkened. The physical aspect of closer objects being brighter is automatically recorded

on the camera film which is activated by light intensities under ordinary conditions of illumination.

When a selected area is specifically illuminated to produce contrast effects and command attention, distant objects may be perceived as brighter partly due to the incongruity, or with subjective allowance for shadow effects. The technicians in the motion-picture industry are especially skillful in producing these effects.

Another phenomenon related to brightness perception is that of brightness constancy. We tend to judge the brightness of a known object, not by the total amount of light it reflects, but by the percentage of light it reflects. Thus the light entering the eye from a distant whitish-gray object may be far less than the amount reflected from a nearby black object (coal in sunlight) yet we perceive the distant object as brighter on the basis of the percentage of light reflected.

Shadows

Ordinarily shadow is produced when light strikes any object. Leonardo made a differentiation between cast shadow and attached (surface) shadow. The shadow cast by one object on another object (the shadow of a telephone pole on the ground) shows the spatial relation of the object to other objects in the field. This type of reproduction (on canvas as well as in the film industry) is used constantly to produce depth effects. If a series of pits (such as bomb craters) are shown with the shadow on the edge away from the observer as though the light were coming from behind him, the depressions are readily perceived. Should the light appear to be falling toward the observer so the shadow is closer than the object, the craters become mounds. Without this shadow the areas in question would appear as circles on the ground in either view.

Attached or surface shadow gives tridimensional relief to an object by virtue of the shadow falling on the object which produces it. Examples are the shading seen on faces (so well exemplified in *The Long Voyage Home*), the irregular appearance of a crumpled handkerchief, the folds of clothing, and the relief shown in still life paintings of fruit and decorations.

Perspective Cues

Leonardo described three types of perspective cues which were effective in reproducing the relative distances of objects in visual space. These are aerial perspective, detail perspective and linear perspective.

In aerial perspective the objects present a changed appearance due to the effects of atmosphere. Since haze reduces brightness judgments, the outlines become indistinct and the objects are judged to be more distant. In murky weather (smoke, fog or smog) the same factor of blurred outlines of distant objects causes us to judge them farther away and larger than they are. In the refined air of clear open spaces we judge distant objects to be much closer than they are and therefore markedly smaller.

Our percepts are so uniformly affected in this respect that it is easy to accept the sudden appearance of a very large ship at sea quite close to us when seen through the veil of artificially produced fog when viewed on the screen. We can almost "feel" the ship bearing down on us. When a plane runs into a mountain in a storm or fog it is often a result of the pilot seeing the blurred outline and judging it farther away than it actually is.

Aerial conditions also cause colors to lose their purity, so that distant objects appear a darker shade of color than similar objects nearby. Trees at a distance appear as dark bluish-green whereas those close appear a bright yellowish-green. Bright sunlight falling on our lawn tends to produce a yellowish percept, hence the other fellow's grass is always greener.

Detail Perspective

This refers to the loss of fine detail, e.g. the fine lines, angles, shapes and shading of an object, with distance. The image is smaller and therefore not as clear in its details; the clearer and more detailed it is, the closer it seems to be.

Detail perspective has been used in a most effective manner by the film industry not only in its natural setting but also in an unorthodox manner to direct attention to a specific plane of a bidimensional picture, the latter being possible by virtue of the aberrations in the camera lens.

The camera lens must be focused to a plane of limited range. The actions and faces in the foreground may be distinct while all objects in the background are slightly blurred. Since we pay attention to the face or action we tend to ignore the hazy background much as we do in everyday life. When the lens focus is changed from near to far our attention accepts the clarity of the distant objects and reconciles it readily with the fuzzy appearance of the surrounding foreground as we do naturally every day.

This subjective percept (as a consequence of the camera lens system) is produced without any accommodative change in our own eyes. In everyday life this peripheral blurring of nearby but laterally located objects is a normal result of active accommodative changes.

Linear Perspective

The third of our perspectives is linear, and is partly related to decreasing angular size with increasing distance. The art work of ancient Egyptians appears flat for they drew all forms (men and animals) the same size regardless of distance. Parallel lines before us appear to converge either into the distance ahead or toward the sides. The Chinese used linear perspective but all their figures were of the same size. It was the artists of the Renaissance who coupled linear perspective with the visual angle subtended by distant objects to lend proper perspective to their work.

The camera lens captures faithfully the objects in various scales in terms of distances and convergence of lines directly ahead, e.g. railroad ties, highways, etc. The laterally converging lines cannot be readily incorporated into most motion-picture films due to the limited field of view. The Cinerama system of film production does capture this cue to space perception.

Interposition

Probably the most powerful of all cues to relative depth perception is that of interposition.* Known as "overlay of contours" it is one of the oldest recognized cues, found in old Egyptian reproductions and in Grecian works of art. At times it is the only cue available, and it has turned out to be the most important cue to distance in vision, in paintings and on film.

The nearer objects in the field of view overlap or cut off parts of more distant objects, so the latter are perceived behind the closer objects. This is a natural consequence of the spatial position of the objects and their lack of transparency.

In all experimental procedures where the various cues were pitted one against the other interposition proved to be the most potent. There is little need to relate this cue to the films, it is so self-evident in everyday vision, in all rational art and in all motion-picture projections, Cineramic or three-dimensional films.

Movement Perspective

Leonardo found that the cue of motion parallax* (movement perspective) could not be incorporated into paintings. This visual cue contains a time element in which motion is involved; it cannot be reproduced in paintings or snapshots but it is readily captured for presentation as a motion picture. A distant object such as an airplane appears to move more slowly through the visual field than a plane which is closer. In the case of

two horses running across the field of view at the same speed, the nearer animal appears to cross the field faster. The consecutive motion-picture frames thrown on the screen convey the percept of motion by falling closely together. This apparent motion is explained in terms of the phi phenomenon, also widely used to convey motion in advertising signs.

Another phase of the above described motion parallax is well illustrated when the observer is moving and the objects in the field of view are stationary. The motion-picture exposures associate the viewer with the actors in a rapidly moving train or speeding vehicle. Near objects (telephone poles and trees) appear to fly rapidly in the opposite direction. Far objects appear to move with the observer, while intermediate parts of the scene appear to stand still. The percept of composite movements in the different parts of the visual field gives the observer an excellent cue to distance and his own speed.

A one-eyed person gazing at two stationary objects in his visual field can readily determine their relative positions by motion parallax. If he sways his head from side to side the closer object will appear to move in a direction opposite to his head movement and distant objects will appear to move in the same direction. It is not possible to experience this percept on the motion-picture screen with the exception of the three-dimensional films which give a paradoxical effect. However, the three-dimensional projection demands the use of two eyes, integrated in a binocular pattern, and thus far we have been discussing so-called monocular cues to depth perception.

Use of Color

Another cue to effective depth representation in paintings and in some motion pictures is the use of color. If a series of colored objects, all of the same size and shape and brightness value are viewed against a dark background they will appear to stand out in space in the spectral order of red as closest, followed by yellow, green and blue. Judged on the basis of the visual angle, the nearer object is reported as smaller; if on the basis of distance, it will be judged larger. Here we have interaction of subjective phenomena.

If the same objects are viewed against a light background the green seems closest, followed by blue, red and yellow. Contrast effects of brightness must be controlled to obtain these phenomena, and this is done by skillful artists. Since brightness is a stronger cue than chromatic effect (and more easily controlled) the motion-picture industry can place any color in the foreground by controlling its brightness in chromatic filming.

MANIPULATION OF CUES FOR REALISTIC EFFECT

Two eyes are not a requisite for depth perception. Visual acuity is basically a monocular function, and is founded anatomically upon the concentration of cones in the central area of the retina to "grasp" and hold a visual object. The act of fixation is also monocular in nature, placing the object in the center of the visual field. The object is "speared" in a definite spatial relation in the egocentric field. The spatial cues are instrumental in supplying the rest of the information and the animal with panoramic vision sees the world in the three dimensions of its correlates, not as a flat photographic reproduction.

Monocular Representations

The one-eyed person has a sort of panoramic vision as have the cross-eyed person and the amblyope* who use cues primarily from one eye. There are few animals who are restricted to panoramic vision, but let us consider the application

of these monocular cues to panoramic vision.

The early painter Alberti noted the problem of three-dimensional representation on a bidimensional surface, and the Renaissance artists attempted to reproduce spatial qualities on their canvas as they were imaged on the retina.

Viewing a painting with two eyes destroys the effectiveness of spatial relations for the binocular cues of flatness contradict the carefully produced monocular cues. All art fanciers know that almost lifelike effects can be perceived in paintings when these are viewed through a short tube monocularly.

More impressive effects can be produced by manipulating or exaggerating these cues. Some famous artists used one cue and other workers emphasized another, but none of the Masters painted objects as they were; some aspect of the creation was distorted to produce some artistic effect. There is evidence that some of the exaggerations were a result of visual defects in some of these Masters.

The Rembrandt pictures show the effect of highlights and shadows produced by creating special light effects (he painted by candlelight). El Greco produced his effects by employing color. Rubens painted his figures in detail and oversized so they appear in front of the plane of the canvas. The background is hazy with an absence of detail effect which enhances the predominant figure in the scene.

Great paintings incorporate the viewer into their context and exert their effects accordingly. The addition of a curved projection screen with lateral reinforcement of visual cues adds reality to the percept. The sum total of all these effects is the major aim of the Cinerama projection.

CINERAMA

We would like to apply the cues to depth perception to the viewing of the Cinerama films. We need no other factors for an analysis, for these are all essentially monocular conditions, even though two eyes are used. Since most persons are binocular (two-eyed vision), we shall consider binocular viewing of this film, ignoring the special functions which operate on a different basis and which are restricted to the three-dimensional system of polarized* viewing. These functions have little bearing at this time, but certain adjuncts should be considered.

Outside of man and the rest of the primates no other form has precisely the same type of visual functions even though the basic denominators are commonly shared by all. As pointed out earlier, the primitive panoramic vision of 360° was a result of the lateral position of the eyes. This was followed in the higher forms by partial overlapping of the visual fields (with binocular vision) reducing the single panoramic field to a total field of approximately 200° in man.

The Binocular Field

The common binocular field, centrally located, covers an angle of 130°, with a temporal crescent of 35° on each side in which the primitive panoramic vision still functions. It is this temporal crescent which gives us percepts at the extreme periphery of our spatial world.

The spatial entity of the horopter is a basic phenomenon of vision. It is beside the point to dissect the horopter in terms of purely binocular spatial components. Whether set up on the horopter or not, our subjective space world is curved, extending from one extreme periphery in an arc in front of us to the extreme of the other periphery. The bilateral monocular peripheral crescents fill out the space world, which is just what Cinerama attempts to reproduce on another spatial cue, which is lacking in three-dimensional polarized

projection as well as in the old-time "flats."

The Cinerama Screen

The motion-picture innovation Cinerama requires a huge screen 26 ft high and 51 ft wide. The screen is curved to simulate the curvature of space extending into the periphery.

Since an ordinary curved screen would tend to reflect rays to converge in some areas of the theater it was necessary to devise some special method to avoid the glare. The screen consists of 1100 to 1500 vertical strips of special tape (baffles) set at angles much like slats in Venetian blinds when partially drawn. The reflections, instead of converging into the theater bounce off from the slats and are lost behind the screen.

It is claimed that the projected panorama fills a field of view subtending an angle of 146° horizontally and 55° vertically. Anyone knows that the size of the visual angle is a function of the distance of the observer so this distance should be specified.

Perhaps a better comparison would result if we compared the sizes and areas of the regular average-sized screen with the Cinerama screen using the distance of "preferred seats" located about fifty feet from the screen.

The ordinary screen measures 22 × 26 ft with an area of 572 sq. ft, subtending angles of 25° and 29°, respectively, at 50 ft. Since the zone of greatest attention is approximately 5° (angle subtended by the macula* of the eye) the peripheral zones are about 12° on each side when attention is in the center.

The New York Cinerama screen is 26 × 51 ft wide; the Chicago screen (Palace Theatre) is 28 ft high and 6 ft on the arc, measuring 28 ft by 59 ft for visual angle comparisons. The total area is 1904 sq. ft on the curved surface, and about 1652 sq. ft for area of effective retinal stimulation. The visual angles are 31° (vertical average) and 84° (horizontal). We now have about 40° (at least 28° more) on either side than on the conventional screen. Comparison of the areas shows that the Cinerama picture covers almost three times the area of the conventional screen.

The Projectors

Three projectors are required to project three separate pictures onto the curved screen in a "cross-fire" position, the center projector covering the middle section of the screen; the left projector covers the right part and the right projector covers the left panel. The projectors are about 20 ft apart and must be mounted even with the center of the screen so the conventional built-in single projection booth cannot be used.

The projected pictures meet quite neatly, and the slight line of separation is obliterated by having small teeth of steel in each projector set at the side of the film track. These teeth jiggle up and down, causing a slight blur at the edge of the screen image. The slight blur goes unnoticed and the line of separation is eliminated.

All the monocular cues to depth perception thus far described are operative in the Cinerama projection. Sizes of retinal images change with the distance of objects; the perspective cues (aerial, detail and linear) are automatically presented and accepted; interposition acts effectively as always, and motion parallax shows its effect with linear movement. The chromatic depth effects are present only in colored projections and only when planned with respect to brightness.

Unique Cineramic Percepts

Cinerama offers two other unique features absent in all other flat projections. Normally as we move forward, we are dependent on what we can see to the right and left. These peripheral objects appear to move out (to the right and left) and curve around us backward to either side. This apparent movement helps us to judge the

distance straight ahead and tells us where we are. The very wide angle of vision and the curved screen in Cinerama both serve to make this a most important cue to tridimensional vision.

In the field of art, great pictures capture and "manipulate" the observer so he becomes part of the scene. His egocenter is in the center of the visual space set by the canvas or by Cinerama. If you must look for the details of tall objects in a painting you feel small. When you look down over a valley or into a gorge you "feel" you are on top and some persons become dizzy.

In Cinerama we actually sit in the lead car of a roller-coaster as we top the rise of a track. The view is spread out before us. As we "plunge" down the incline the field quickly enlarges with the more peripheral details flying outward and around (past us) adding a terrifying realism to the experience, causing many in the audience to grip their seats. In the same manner we glide along slowly in a gondola while the panorama on either side slides by slowly, or we fly through valleys between walls of canyons which we can almost touch.

The second visual effect of realistic depth is that when we turn our eyes to look at an object at an angle it is actually seen closer to us. Objects in the center appear to be 50 ft away but those at the edge of the screen are only 44 ft away.

Stereophonic Sound

Another cue to depth perception is that of sound. Normally we not only localize a sound in terms of its direction but also on the basis of the same sound reflected from walls and nearby objects. The nervous system integrates these direct and reflected sounds with the visual data into a composite whole.

The special Cinerama sound system attempts to duplicate these conditions. The sound tracks are made at the actual point of origin of the sound and even loudspeakers are set up on a huge arc extending half-way into the theater reproducing the sound effects from the directions in which they were originally recorded when the film was made. By virtue of this added auditory cue the individual actually feels himself in the midst of the action. In the chapel scene an invisible choir seems to advance from the rear, and many persons actually turn their heads toward the voices which seem to advance down the aisles.

There are no miracles in this production, just great ingenuity. Seeing things in depth is no intellectual act, but seeing them flat is such an act. Cinerama can cause one to float on air, to feel small or large, or to feel a fall through space. These things are true only because they are true for real life and this is just what Cinerama attempts to reproduce.

Cinerama takes into consideration the one-eyed individual. The cross-eyed person can experience all the illusions. The one with subnormal vision in one eye (amblyope) experiences the same percepts inside the theater as outside. An individual with a cataract* in one eye still sees the picture in comfort using the good eye.

Visual Disturbances

This type of viewing does not produce any untoward demands on the visual apparatus; it is a natural and fundamental type of vision. The pictures are visually comfortable and are based on the fundamental physiology of the eye. There is no tendency to eyestrain and since no special glasses are required there is great freedom of the head and eyes. Tilting the head produces no change in the picture as it does in the case of polarized viewing.

It is possible that Cinerama may prove useful in making people conscious of visual defects or diseases. Those persons who experience difficulties or notice blurred areas, or even find parts of the field missing may have visual field defects which should be thoroughly investigated.

The insidious disease of glaucoma* causes the greatest percentage of blindness in people over forty years of age. In many cases symptoms are so minor (or absent) they are ignored. One of the symptoms in advanced glaucoma patients is the reduction of the peripheral field. In the case of retinitis pigmentosa the field constricts from the periphery toward the center leaving only a small central zone. There are other systemic as well as visual disturbances which affect the peripheral visual fields and peripheral perception. On the whole the innovation which is a refreshing attempt to rejuvenate the motion-picture industry may prove useful in other ways.

STEREOPSIS*

A Binocular Clue to Space Perception

The beginning of binocular vision is found in primitive vision (fish) in addition to panoramic vision. The concept that depth perception is a result of binocular cues added to bidimensional vision is totally incorrect. The prevalent idea that a form with laterally placed eyes sees everything as flat and separately with each eye is just an idea and nothing more. A field common to both eyes is present even in panoramic vision.

Many primitive forms have a fovea directed laterally and a more temporal fovea whose axis is directed into the common binocular field straight ahead. As the eyes migrated forward in evolution these two foveas evolved in different directions. In lower forms the pair of temporal foveas predominate as an original mechanism. The owl with a pure rod retina has no central fovea but it has well-marked temporal foveas which mediate depth cues by triangulation. There is no fusional vision or true binocular vision based on stereopsis.

Stereopsis by triangulation is replaced by stereopsis based upon physiological diplopia.* With the emergence of binocular vision with fusion we find the human fovea in the center of the binocular visual field. With the enlarged binocular field we find so-called corresponding retinal areas in the two eyes. The nerve fibers from the left half of each eye go to the left half of the brain; the same arrangement prevails on the right side. This is the anatomical basis for fusion,* a relatively late acquisition.

Due to their separation the eyes receive slightly different views of an object. Look at a three-dimensional object first with one eye and then with the other to verify this fact. Leonardo da Vinci had noted that the two eyes look at objects from different vantage points and that they can see the whole space behind small objects. He knew that the painter could not reproduce this effect of looking "around" objects, and artists have to duplicate the pattern as seen by a single eye.

Leonardo did not realize, however, that the images on the two retinas were not alike. He did not notice the fact that the relative positions of the eyes change with distance. For these reasons he was unable to conclude that the position of the two eyes with their different perceptual processes gives us a valuable binocular cue of a tridimensional order which cannot be reproduced on canvas. The reason Leonardo missed this fact is that objects represented in flat drawings are very similar (almost identical) when viewed monocularly.

This notable discovery must be credited to Wheatstone, inventor of the mirror stereoscope. He reasoned that slightly different images are thrown on corresponding areas of the retinas and this slight inequality of the images furnishes the cue to depth perception (generally called stereopsis).

Wheatstone proved his contention by drawing slightly different figures of pyramids and concentric circles (all flat targets) and reflecting them into the

eyes. The result was a stereoscopic percept mediated by disparity clues from the retinas. Although Wheatstone clarified the conditions attendant on stereopsis, the physiological mechanism which underlies the phenomenon is still a matter of controversy.

In summary, the basic cues to space perception (depth) are monocular visual cues. Upon these, the binocular act of fusion is added as a refinement. With the faculty of stereopsis the ultimate binocular cue appears. Stereopsis is a superb qualitative aspect of vision, but persons who do not have it, never feel they miss anything.

Stereopsis is not the strongest cue to depth. When pitted against interposition the latter prevails as the strongest cue to depth perception. Like acuity* and fixation, it is a monocular cue. As a matter of fact it is much more important to see light (brightness) and its gradations (differences) and its effects (shadows) than it is to see stereoscopically.

The one-eyed individual gets along quite well and has learned to allow for his lack of stereopsis. He sees a painting in better tridimensionality than his two-eyed neighbor. He learned to get along well monocularly (we binocular individuals have more choice). Many people go through life with monocular vision or, having it, may lack stereopsis and never know of their defect.

POLARIZED THREE-DIMENSIONAL PICTURES

The present screen for three-dimensional projection is of conventional size; the conversion calls for some aluminizing process so the polarized effect is not destroyed. Whether called 3-D, Triorama or Natural Vision, the basis of the process is the same.

Since Oliver Wendell Holmes popularized the stereoscope many ways have been devised to achieve stereoscopic effects. Two pictures or films must be produced with properly spaced lenses, each one showing the objects at a slight angle. The films are projected to the same plane and some sort of spectacle must be used to separate the two pictures to produce the different images, one for each eye.

One film may be dyed red and the other green as in the Keystone Stereomotivator BSM slides. When the observer wears a red lens before one eye and green before the other the projected pictures are funneled one into each eye. The brain fuses these into a composite percept in terms of realism. This method known as anaglyph cannot be used for viewing Technicolor stereoscopic pictures. Due to this limitation (besides being annoying to some) polarized projection is substituted.

Techniques for Photographing and Projecting Three Dimensions

At the present writing there is only one system in existence for photographing three-dimensional motion pictures using one camera with two lenses. This process, which is fairly simple, requires two strips of film inside a single camera. The distance between the lenses can be varied to control the angle of the shot, to produce a pair of flat pictures (from different vantage points) which will eventually yield a three-dimensional *stereoscopic* picture for *binocular* viewing.

The process called Para-Vision consists of two cameras facing each other, with a pair of angled mirrors between them reflecting the action through the lenses onto the film (purely an extension of Wheatstone's original mirror-stereoscopic device). Variations in the angle between the mirrors produces the disparity effect for binocular viewing.

The distance between the eyes is about 2.5 in. When the lenses of a stereoscopic camera are separated more than this, the depth can be exaggerated. The depth of an outdoor scene or a ballroom can easily be set for 150 ft or more. Since a control of the plane of the picture

is possible, it is possible to achieve some spectacular effects.

The back of the shot can be placed on the theater screen and other details, e.g. a lion, a dancer or a train may appear in space over the front seats in the theater. A reverse effect can also be produced whereby the front of the shot is at the plane of the screen, simulating a natural stereoscopic view which we experience when looking out an open window. An intermediate effect is also possible where some of the objects and action occur in front of the screen and others behind it. A fixed distance between the lens system of the cameras will not produce all these effects, the distances must be adjustable and changed periodically depending on what effect is desired.

During projection should one film in a projector be displaced by even one spoke the stereoscopic effect will be distorted, resulting in visual discomfort. Should the difference become even greater the stereo-effect disappears to be replaced by an overall percept of double vision (diplopia). For this reason the two projectors must be synchronized exactly. This calls for an interlocking system which sets up a rigid 1:1 relationship. This is of prime importance for exposing the corresponding frames and keeping the sound effects in synchronism as well. Both projectors must be started simultaneously by a common switch with no lag in their operation.

Polarizing Filters

Light polarizing filters with polarizing axes of 45° and 135° are inserted in the portholes of the projection booth. These angles must be maintained precisely or disturbing effects will result. There is a double picture on the screen, each polarized in its respective direction. Viewed without light-polarizing goggles an annoying double exposure is seen.

The patron, wearing his goggles with axes 45° and 135° looks at this double exposure; each filter before his eyes allows only one of the pictures to stimulate the retina. Based on disparity cues, the brain of a binocular person elaborates the precise details of a stereoscopic percept, even more realistically when seen in color. Optometrists are familiar with this light-polarizing principle used extensively in the Wirt stereopsis test, the Vectograms and the Ortho-fusor training cards.

The glass filters of the Ortho-fusor goggles may be used to view the polarized movies, but polarized sunglasses cannot be used since their axes of polarization are 90° and 180° in the two lenses. It is possible to have regular lens prescriptions ground into polarized lenses so the patron who must wear glasses at the theater will not have to bother with two pairs of glasses.

Light Source Problems

Several important considerations arise with respect to the light source used for projecting. There is a 70 to 80% light reduction when light passes through polarized filters. If the theater screen is increased in size (and this either is being done or is contemplated) the light must pass through larger polarized screens being reduced still further. Powerful new screen-lighting equipment of an arc-lamp type is in production to overcome this difficulty. The increase in reel size (to avoid more than one intermission) means that the burning life of the arc-lamp must be increased to an hour without retrimming.

Using a dual light system still another factor is involved. The eye is capable of discriminating a brightness difference of 1%, so the two beams of projected light must be identical in intensity and color value. Unless the lamps are matched to a high degree of precision with very small tolerances, eyestrain may result. Designers of the lamps are striving for a constant condition at the burning arc which can be automatically maintained.

Using these more intense light sources

produces another condition which must be rectified. These lamps generate a terrific amount of heat, necessitating blower-fans and water-cooling systems of higher efficiency.

Comparison of Depth Effects

The flood of three-dimensional movies is fundamentally based upon engulfing the spectator by means of peripheral vision, or by captivating his attention by means of stereopsis based on binocular vision. Both systems are based on sound physiological principles and eventually should be combined if technical details can be worked out. More details need attention in the three-dimensional projections than in the engulfing system.

In the case of the polarized-light system, critics have complained that the glasses are uncomfortable and that they have an odor; both of these are minor complaints and can be rectified. While registration of detail in polarized presentation was excellent, the color quality was poor in *Bwana Devil*. The light intensity must be increased with better subsequent standardization of controls. All these will follow from experience. Optometrists who saw *Bwana Devil* were too critical, they experimented by head-tilting which tends to destroy the stereoscopic effect and produces ghost-images.

In polarized projection every seat in the house can be sold whereas in the engulfers the side aisles cannot be used for effective viewing, the house selling "choice-seats" in the center of the theater approximately fifty feet from the screen. Everyone can view Cinerama or the CinemaScope productions, but any person who is restricted to the use of one eye (monocular person, strabismus, anisometropia,* aniseikonia,* amblyopia) cannot experience the depth effect in the polarized projection. Since there is childhood loyalty to playmates, the practice of an entire family or of couples going to the movies together, the one-eyed viewer may be instrumental in cutting down attendance of others at polarized pictures.

Drive-in Problems

Application of either system to outdoor theaters is rather remote. Even though the huge curved Cinerama screen could be built, persons sitting in an automobile (particularly in the back seat) have a limited field of vision, the peripheral pictures being cut off at the sides of the car. Since there is an in-car speaker it would be impossible to reproduce the stereophonic sound effects; without this sound illusion the value of peripheral projection is greatly decreased.

The drive-in situation is no better in the case of polarized projection. The reflected light from the outdoor screen is only four to eight candle-power in contrast to the ordinary theater reflection which is significantly higher. A further amount of light is lost at the windshield, and some of the modern tinted windshields will not transmit polarized light at all. The suggestion of placing a double piece of polarizing material on the windshield would aid only those who could sit on the direct line of the separating seam. This arrangement is highly impractical.

Hollywood Status of Problem

In the meantime there is much hysterical thinking in Hollywood on these problems — as well as mischievous publicity. One company is working on depth pictures to be viewed without goggles; another is experimenting with a "secret" method; and still a third makes extreme claims in print.

The technical engineers need instruction and must study facts of stereoscopic vision; the directors must learn about space perception; and the cameramen must change their techniques.

To say that one method is more natural or that another *may* cause eyestrain is to ignore facts or deny virtue when present. Any method will produce eyestrain under improper conditions of

viewing. Random comments of critics (even actors and actresses) should not be amplified for sensational publicity releases. Bogart and Boyer, Crawford and Davis, will all show wrinkles and their age under certain conditions, but we can still count on the skill of the make-up artists to eliminate these wrinkles from the searching scrutiny of the three-dimension systems' lenses, because they can work with the monocular visual cues which are the fundamental cues to depth perception.

New Problems Created

The advent of three-dimensional motion pictures promises to create new problems for optometrists and other scientifically minded groups. The movies are not harmful to sight but on the contrary may be quite beneficial. Those who have amblyopia or anisometropia and do not wear glasses, will become acutely conscious of their monocular percepts and should seek professional aid. Those with poor stereopsis may benefit much as they do in visual training and orthoptics* administered in the optometrist's office. I can think of no better training for a strabismic individual who shows a binocular pattern and who can straighten his eyes upon demand than to view polarized stereoscopic projections at the movies to stabilize binocular vision.

Others experiencing difficulty in enjoying depth effects may have field defects which should be thoroughly investigated by their vision specialists. Depth motion pictures may uncover much pathology and help realize visual defects demanding attention. This is of special importance in the case of children, the citizens of tomorrow.

Some persons may have poor acuity in one or both eyes; they may have fusional difficulties, poor stereopsis, suppressions,* muscular anomalies and insufficiencies, anisometropia and aniseikonia. All these are manifested by poor binocularity, interfering with efficiency of binocular visual functions.

Some of the patients (referred via three-dimensional movies) may show cataracts. If glaucoma is present, referral to the proper *qualified* vision specialist may save the person from eventual total blindness. Identification of a neural lesion based on analysis of a visual field defect may save a life if surgical intervention is instituted early enough.

Motion pictures in depth are here to stay. It behooves us, as optometrists, to study all the facts of three-dimensional motion pictures and Cineramic productions and learn how to diagnose, correct or refer those patients who cannot enjoy the benefits of both Cineramic *and* polarized projections. These patients may become as common in our respective practices as the "ordinary refractive case."

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GLOSSARY

Acuity: Sharpness of vision in respect to the ability to resolve detail. It is usually expressed as the reciprocal of the minimum angular separation, in minutes, of two lines of detail which can be separately seen. For the average person it is roughly an angle of one minute.

Amblyopia: A reduction in visual acuity

which cannot be improved with lenses and which is not caused by any active disease.

Aniseikonia: An anomaly of binocular vision in which the ocular images differ in size or shape or both, making fusion difficult or impossible.

Anisometropia: A condition in which the refractive status of one eye differs from that of the other.

Cataract: A pathological condition of the eye in which the crystalline lens loses its transparency and becomes yellow and opaque, causing a reduction in acuity proportional to the opacity.

Diplopia: Double vision of a single object.

Fixation: The act of placing the image of an object directly on the fovea (looking directly at the object).

Fovea: The central area of the macula, comprised of minute cones, and subserving most acute vision. This is the most sensitive area of the eye for visual acuity.

Fusion: The faculty of superimposing the two central images of the retinas and projecting them into space as a single image.

Glaucoma: A disease of the eye marked by increased intra-ocular pressure resulting in hardness of the eye, atrophy of the retina and eventual blindness if not treated early.

Horopter: The locus of points in external space whose images are formed on corresponding places of the two retinas and which are therefore seen single.

Interposition: Overlay of contours, so that nearer objects in the field of vision overlap or cut off parts of more distant objects to make them appear in the background.

Macula: The yellow spot of the retina surrounding the fovea, composed of cones and containing the fovea.

Orthoptics: Correction of vision through exercises or training, especially as related to strabismus.

Parallax: The apparent change of place which objects undergo by being viewed from different points, or under different optical conditions.

Polarization: Elimination of light waves from all but a desired plane.

Stereopsis: Visual perception of solidity or depth by binocular cues.

Strabismus: A deviation from parallelism of the two eyes due to muscular incoordination in which binocular fixation does not exist; the fixation is monocular.

Suppression: Voluntary, though often subconscious, withholding of vision, usually in one eye. It is often the result of one's attempt to avoid discomfort from binocular vision.

70mm Test Vehicle Recorder

By CHARLES T. LAKIN

A small camera is described which takes $\frac{1}{5}$ by $2\frac{1}{2}$ in. pictures at rates up to 450 frames/sec on 70mm film. The film is stationary during exposure. The total weight of the camera is 25 lb. Its long thin aperture shape, its high frame rate and its small size should make it a useful tool for work in ordnance and in aircraft and machine design.

THE 70mm Test Vehicle Recorder (TVR) is a specialized camera designed for high-speed measurements. It was designed originally for photographing rockets being launched from aircraft in flight, but it is ideally suited to photograph such things as high-speed vehicles, missiles, aircraft components in flight or machine motions.

Description

The 70mm TVR has the specifications shown in Table I.

Although the frame rate is very fast the film is held stationary during the exposure; therefore, it is not necessary to compensate for film motion either optically or by means of a high-speed shutter.

The exposure is equivalent to that of a 90° rotating shutter. Any smaller-sized opening can be used by disassembling the camera and replacing the present shutter with one having the desired opening.

The lens now used is a Zeiss Universal Tessar, 2-in. focal length, which has a maximum aperture of *f*/4.5. Its angular coverage is $58\frac{1}{2}°$ across the $2\frac{1}{4}$-in. aperture measurement. A little better resolution is obtained at the corners of the picture if a Zeiss Universal Tessar, 3-in. focal length, *f*/3.5 lens, covering 42°, is used.

The motor now used is $\frac{1}{2}$-horsepower, 28-v d-c. This motor was chosen because the present use of the camera is to photograph objects aboard an aircraft in flight.

Table I

Nominal frame size	$\frac{1}{5} \times 2\frac{1}{4}$ in.
Maximum frame rate	450 frames/sec
Total film load	80 ft
Total weight	25 lb
Length, including lens	$9\frac{1}{2}$ in.
Height, including base plate	$8\frac{7}{8}$ in.
Width, including motor	$11\frac{1}{4}$ in.
Width, excluding motor	$6\frac{1}{4}$ in.

Presented on October 9, 1952, at the Society's Convention at Washington, D.C., by Carlos Elmer for the author, Charles T. Lakin, Code 3531, Aviation Ordnance Dept., U.S. Naval Ordnance Test Station, Inyokern, China Lake, Calif.
(This paper was first received September 24, 1952, and in revised form on March 16, 1953.)

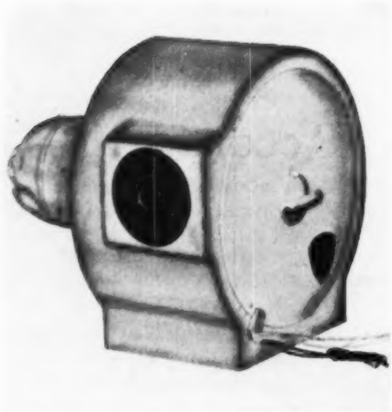

Fig. 1. Outside configuration of 70mm Test Vehicle Recorder.

In Fig. 1 the outside configuration of the camera is shown. The large, heavy base-plate simplifies mounting the camera stably, even aboard aircraft. The lens is easily removed by taking out 6 screws. All adjustments of focus and aperture are clamped down for the aircraft use.

In Fig. 2 the camera is shown loaded with film, ready for the door to be closed. The 70mm film is wound on daylight-loading spools. It can be seen that every adjustment interlocks with the door, so that the door cannot be closed and locked unless everything inside the camera has been adjusted correctly; also all parts must stay so adjusted until the door is opened again.

The number of moving parts has been reduced to a minimum. Attached directly to the motor shaft are an 8-in. diameter drum, a gear and a cam. The drum is the shutter; the gear drives the drive sprocket wheels and the take-up spool; and the cam operates the film-pulldown claws.

The shutter-drum has four openings approximately $1\frac{1}{2}$ in. in height. This height gives excellent shutter efficiency and practically no focal-plane effect because of the large height of the openings. It is the drum which limits the camera speed, for in preliminary tests the drum stretched out of shape at 580 frames/sec. However, the present shutter-drum and the present film-handling mechanisms have been operated at 510 frames/sec with no mishap.

The film-pulldown claws are operated from a cam. There are two sets of claws working alternately. Each of the two sets of claws is composed of four claws, two on each side of the aperture, making a total of eight claws. The timing of the claws is such that one set of four claws never pulls out of engagement with the film until the other set of four claws has made engagement. Thus the eight pulldown claws are controlling the exact position of the film at the aperture at all times almost as positively as positioning by registration pins.

In Fig. 3 the camera is shown with the aperture plate and the back pressure-plate removed. Such removal is necessary for cleaning the camera, and it is advantageous in focusing of the actual image on ground film. On the aperture plate are two small lucite rods which transmit light from two neon timing lamps onto the upper two corners of the picture. There are also two small fiducial marks on the top margin, each one-half inch from the corner of the aperture.

In Figs. 2 and 3, under the "caution" sign and touching the inner edge of the film, can be seen a small metal plate which is the arm of a switch. This switch, called the finish switch, actuates a relay for turning off power to the motor after all the film has been exposed.

In Fig. 4 is a sample of pictures taken with the camera. The subject is an automobile running at 60 mph. Notice the two fiducial marks in the upper parts of the picture. The frame rate is approximately 300 frames/sec.

The advantages of this camera all seem to result from four characteristics:

1. The camera has a high frame rate. Although several cameras record at

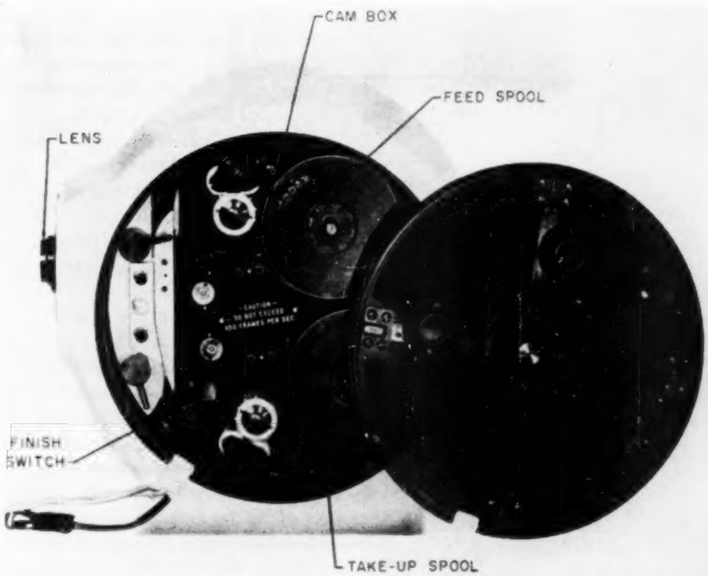

Fig. 2. The camera loaded with film, ready for the door to be closed.

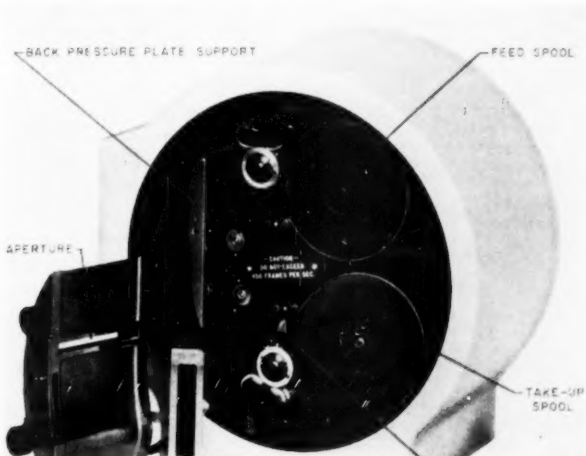

Fig. 3. The camera with the aperture plate and the back pressure-plate removed.

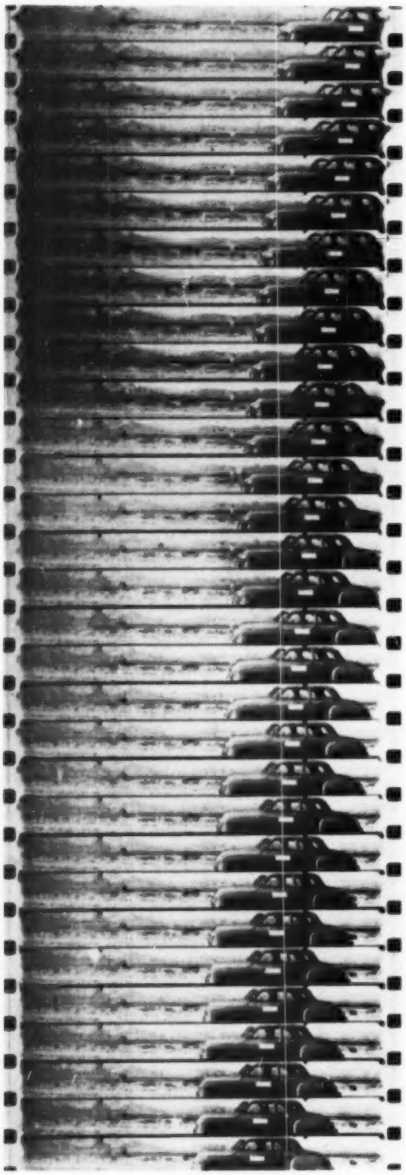

Fig. 4. Sample of pictures taken with the camera.

many times this rate of 450 frames/sec, still this rate places the camera in the high-speed class for recording most machine motions, rocket launchings and flights, or aircraft components in flight.

2. The film is stationary during exposure. The shutter action and the intermittent film action cause no loss in resolution or distortion. The quality of pictures from the camera then is limited only by the quality of the lens, the film and the operator.

3. The frame shape is such as to give maximum information. Since objects for high-speed photography in this speed range of, say, 50 to 450 frames/sec are usually moving in essentially a predetermined straight line (rocket launchings, missile trajectories, high-speed vehicles or machine motions), the 10 to 1 ratio of width to height is very convenient. This aperture size is $\frac{3}{4}$ as high but $5\frac{1}{2}$ times as wide as a normal 16mm frame.

4. The camera is small and light. These features allow mounting it on an aircraft or other vehicle, and they make the camera very portable.

The camera has been used a number of times on the ground and aboard aircraft in flight with excellent performance results.

The camera is a product of Producers Service Co., 2704 W. Olive Ave., Burbank, Calif.

High-Speed Motion-Picture Photography of Electrical Arcs on a High-Voltage Power System

By EVERETT J. HARRINGTON and HAROLD C. RAMBERG

In order to obtain data on deionization times of high-voltage fault-arc paths the Bonneville Power Administration has made oscillographic and photographic records of electrical arcs produced on 115- and 230-kv buses with current magnitudes up to 25,000 amp. Speeds of 4000 frames/sec were used. Since the arcing times were very brief (0.1 to 0.01 sec), camera timing was critical. This, and estimation of the actinic value of the self-luminous arc, were the principal problems encountered. Another problem was photography of a self-luminous arc of high intensity against a background which must also appear in the picture when the arc is out.

The advent of high-speed motion-picture cameras has enabled the dynamic characteristics of many types of action to be recorded. Subsequent projection of these records at greatly reduced speeds, or examination of single frames, has made possible visual analysis of such action to a degree not heretofore attainable. This technique has been applied to actions ranging from the various forms of mechanical motion to nuclear explosions. It is the purpose of this paper to describe the technique employed in the photography of high-voltage fault-arcs in air which were produced on a modern high-voltage power transmission system.

Presented on April 30, 1953, at the Society's Convention at Los Angeles by Harold Levinton for the authors, Everett J. Harrington and Harold C. Ramberg, Bonneville Power Administration, Box 3537, Portland 8, Ore.
(This paper was received on April 28, 1953.)

Recording of Power Circuit Breaker Performance

High-speed motion-picture photography was first used by the Bonneville Power Administration in 1946. At that time BPA undertook to test a 230-kv power circuit breaker which had been confiscated by the armed forces in Germany. This breaker was radically different from any American breaker, and particularly in that the interrupting contacts were not enclosed. Since this construction permitted ready observation of the arcing process during the interrupting procedure, it was decided to photograph this region using a Fastax camera operated at the rate of 4000 frames/sec.

To record this action successfully, several problems had to be solved, the

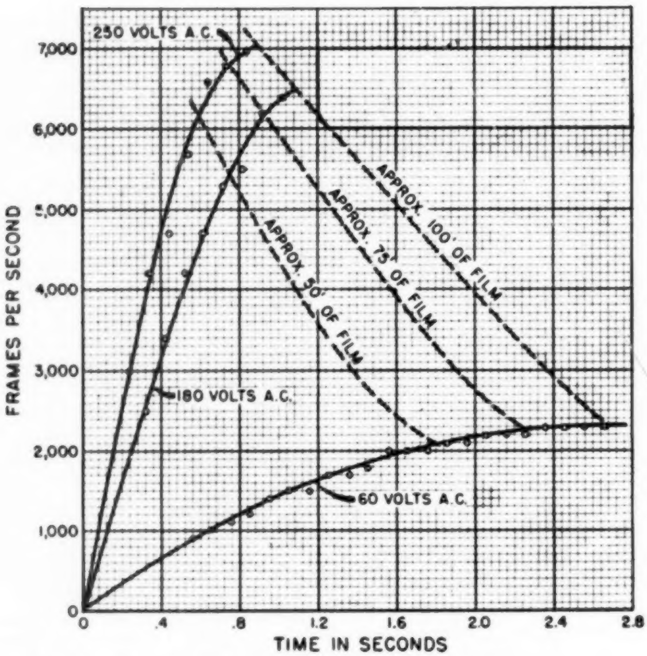

Fig. 1. Speed calibration curves for 16mm Fastax Cameras.

most difficult of which was perhaps that of providing sufficient illumination. When the breaker contacts part, an arc is formed which, in this case, would have a duration of 0.06 to 0.07 sec. This arc would be maintained by a recovery voltage of approximately 133,000 v at a current density of 6000 amp. Needless to say, the luminosity of this arc would be extremely high and as it was desired to obtain a recognizable picture of the contacts and their supporting structure prior to arc initiation and after extinction, the problem of obtaining sufficient illumination on these areas was, to say the least, difficult. As anti-aircraft type of searchlights were not available at that time, the illumination used consisted of one narrow-beam 2-kw airport ceiling indicator plus 26 kw of semi-focusing incandescent floodlights concentrated as much as possible on an area approximately 6 ft in diameter. Incident light thus obtained was approximately 15,000 ft-c.

The results obtained, while permitting fairly satisfactory observation of breaker operation, were not ideal from an exposure standpoint. Considerable manipulation in development of the negative and printing of the positive was required in order to prevent the breaker areas from disappearing completely. As a result, the self-luminous portions which include the actual conducting portions of the arc and surrounding volume of hot gasses blocked up pretty badly.

Recording of High-Voltage Electrical Arc Phenomena

This first use of the high-speed camera led us to believe that it might be a useful tool in investigating the behavior of

fault-arc paths such as are produced by lightning flashovers on high-voltage transmission lines and the subsequent power follow current. Since that time numerous tests have been conducted involving production of such arc-trails while photographic records of the phenomena were made. These motion pictures plus oscillographic records of electrical variables have enabled analysis of the phenomena and predictions of behavior which have been applied to system design and operation.

Timing Techniques

Inasmuch as the production of faults on large power systems cannot be made with impunity it is essential that satisfactory records of each test be obtained. In order to insure such results, accurate data on camera acceleration and frame speeds must be had and close control must be exercised over initiation of the arc and camera and oscillograph timing.

Figure 1 is typical of the type of camera data necessary. In addition the following information should be on hand:

1. Frame speed at which it is desired to record.
2. Arc duration.
3. Approximate duration of post-arc phenomena to be recorded.
4. Closing time of arc-initiating switch.
5. Interrupting time of fault clearing switch.

With this information and suitable timing equipment, satisfactory records may be obtained providing proper lens aperture is selected.

As an example to illustrate selection of timing sequences let it be assumed that it is desired to photograph an arc at the highest frame speed possible while recording the entire duration of the phenomena. Assume the following data are known:

1. Frame speed desired — maximum possible.
2. Arc duration — 0.1 sec.
3. Duration of post-arc phenomena to be recorded — 0.2 sec.
4. Closing time of arc-initiating switch — 0.1 sec.
5. Interrupting time of fault clearing switch — 0.05 sec.

From Fig. 1 the speed curve for 250 v represents the upper limits for this camera. In this case the running time for 100 ft of film is 0.90 sec. Total recording time (from the sum of (2) and (3) above) is 0.30 sec. This means that the arc must be initiated at 0.90 − 0.30 = 0.60 sec. As the closing time of the initiating switch is 0.10 sec, its initiating signal must occur at: 0.60 − 0.10 = 0.50 sec. As the arc duration is to be 0.10 sec it must be interrupted 0.10 sec after initiation or at 0.60 + 0.10 = 0.70 sec. The interrupting switch takes 0.05 sec to interrupt, consequently it must be tripped at 0.70 − 0.05 = 0.65 sec. Summarizing the above gives the following sequence of events:

Time in Seconds	*Event*
0	Camera voltage applied
0.50	Arc initiating switch tripped
0.60	Arc established
0.65	Interrupting switch tripped
0.70	Arc interrupted
0.90	Camera voltage interrupted

From Fig. 1 it may be seen that this should result in a record approximately 50 ft in length on which the arc will be recorded for about 15 ft at a frame speed from 6100 per sec to 6600 per sec. Post-arc record will be approximately 35 ft in length at frame speeds from 6600 to 7000 per sec.

In actual practice it is advisable to move the events ahead in time somewhat in order to not work too near the end of the film. This allows a margin for variation in running time and flashing at the trailer end if unloading is done under high ambient light.

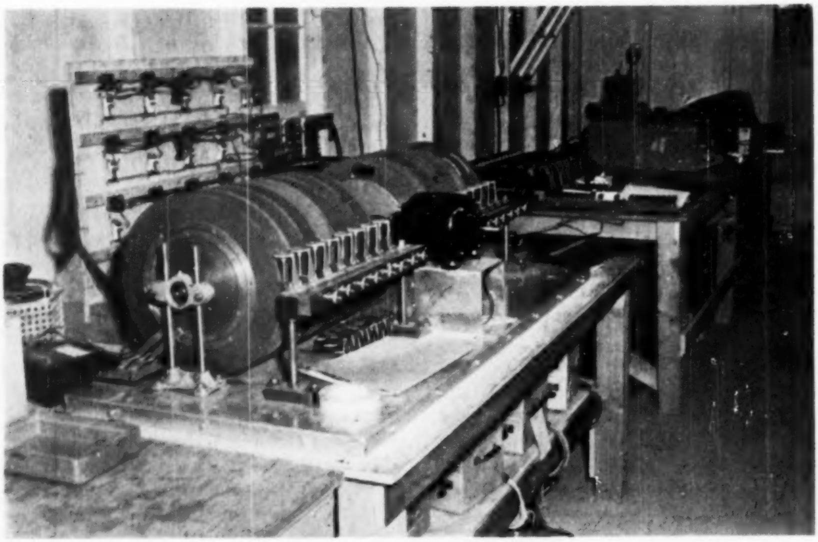

Fig. 2. Sequence timing device.

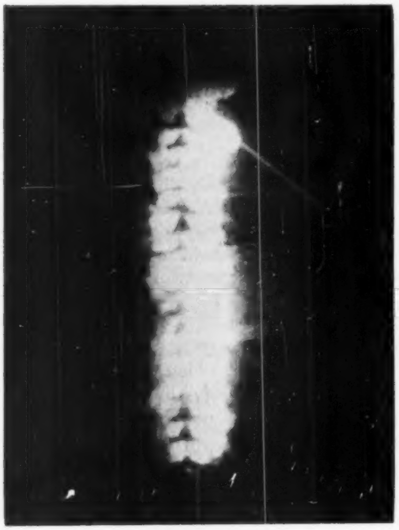

Figure 3A.

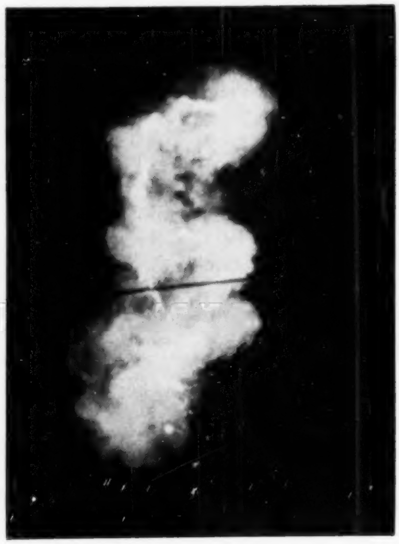

Figure 3B.

Figure 2 is a photograph of a sequence-timing device constructed for controlling timing sequences for these and other types of tests on the Bonneville Power Administration system. It consists of a series of 16 cams driven by a synchronous motor at 1 rps. These cams open or close microswitches which either directly

or through relays control the events. Each cam operating point may be adjusted independently of the other throughout a range of 1 sec. This timer is much more accurate than would normally be required for photographic purposes as it was designed to initiate events on any part of a 60-cycle wave to an accuracy of ± 5 electrical degrees. This accuracy is required for certain types of circuit breaker tests for which the timer is also used. This sequence timer, in conjunction with an Industrial Timer Corp. Model J-410 Fastax Control Unit commonly called "The Goose," has proved quite adequate for a wide range of photographic instrumentation.

Selection of Exposure

Choice of lens aperture for the effective recording of high-intensity arc phenomena is contingent upon which part of the phenomena is of primary interest. If behavior of the arc, i.e. its conducting path, is to be studied, extremely small integrals of exposure must be used in order that the relatively small (in cross section) conducting path may be defined and not masked by the surrounding volumes of incandescent gases. The resistance of these surrounding gases is high compared to that of the central core, consequently they carry only a small portion of the total current. If, however, it is desired to record the behavior of these incandescent gases and such post-arc phenomena as the arc trail, relative exposure must be greater, since the luminosity and actinism of these superheated gases are much less than those of the actual conducting core.

It has been the authors' experience that the conducting core of arcs passing currents of from 5000 to 25,000 amp can be recorded on Super XX film at 7000 frames/sec, using an aperture of $f/22$ plus neutral density filters having transmission factors of from 4% to 25% (depending upon arc current magnitude).

Satisfactory records of post-arc phenomena have been obtained using Super XX film, film speed of 4000 frames/sec and apertures of $f/22$ when the arc trails were the result of a 10,000-amp arc.

Figure 3 (A) shows a single 16mm frame taken with exposure adjusted to record the incandescent gases created by the arc. Note that no details of the actual conducting path can be seen. Figure 3(B) is from a record of an arc of the same magnitude but approximately 1/50 the exposure. Note that in this case details of the intensely luminous core may be observed.

Color film may be used to advantage in studies of arc trail behavior and deionization times. Change in color of the hot gases is indicative of temperature and color film may show such changes within a limited range. Its inherent narrow latitude, however, makes choice of exposure critical if a good record is to be obtained in the region of principal interest.

Discussion

Fred Metlen (Boeing Airplane Co.): In spark-gap work with Kodachrome, I run more than one camera at various speeds. By doing this, the correct exposed portions of each make a complete picture of the action. The high speed takes only the initial flash; the slower speed cameras photograph the important part not shown from the flash.

Harold Levinton (formerly of Bonneville Power Administration, who read the paper): We had only one camera available which did serve to give us the data required. I might suggest that dual exposure levels could be achieved with one camera by using an image splitter with a filter interposed so as to reduce the exposure of one of the images. This would eliminate the necessity for speed correlation between two cameras. Along this same line, dual images obtained by using some form of optical system to simultaneously record two different operations for correlation might be feasible.

Addendum to Progress Committee Report: Developments in Germany

By GEORGE R. GROVES, Committee Chairman

The most significant developments in the motion-picture industry in Germany during 1952 were concerned with the manufacture of equipments rather than with new production techniques. In the manufacture of motion-picture cameras, many well-known firms newly reconstructed after the difficult post-war period were again able to show satisfactory delivery schedules. While, in general, no fundamentally new departures in technical equipment appeared on the market and most firms restricted themselves to the production of standard equipments manufactured with the highest precision, there did appear on the market a number of new cameras for 8mm, 16mm and high-speed photography.

8mm

In the spring of 1952, Zeiss-Ikon brought out a notable new camera for double-8mm film. This instrument features a radical departure from the usual construction in that both film spools are set with their axes parallel to the axis of the objective. The flatter and broader camera shape which results facilitates freehand shooting.[1]

This addendum to the report published in the May *Journal* has been prepared from material submitted in German by Committee Member Leo Busch.

16mm

Considerable effort was expended in the 16mm field to achieve wider industrial use of this type of film. The new Arriflex 16mm camera made by the firm of Arnold & Richter (Fig. 1) was introduced. It is a single-opening, mirror-reflex camera on the principle of the 35mm Arriflex with a turret head holding three divergent lenses. It can accommodate either 30-m daylight-loading film reels or magazines with 120-m reels. It has a mirror reflex viewfinder, free from parallax, on which the image is enlarged approximately ten times. The minimum focal length with the wide-angle lens is 11.5 mm. The lens mounts correspond in size and adjustment to those used by the 35mm Arriflex so that the lenses are interchangeable between the two cameras. The camera aperture is 180°. Exclusive of the magazine, the camera weighs a little over 3 kg.

A number of special 16mm film theaters were established and several well constructed 16mm theater projectors appeared on the market. Among these may be mentioned the new Siemens projector[2] and the Leitz 16mm theater projector.[3] Mention should also be made of a new 16mm film projector put out by Lytax which deviates from the usual design by having the reels placed in a horizontal plane, as illustrated in Fig. 2.

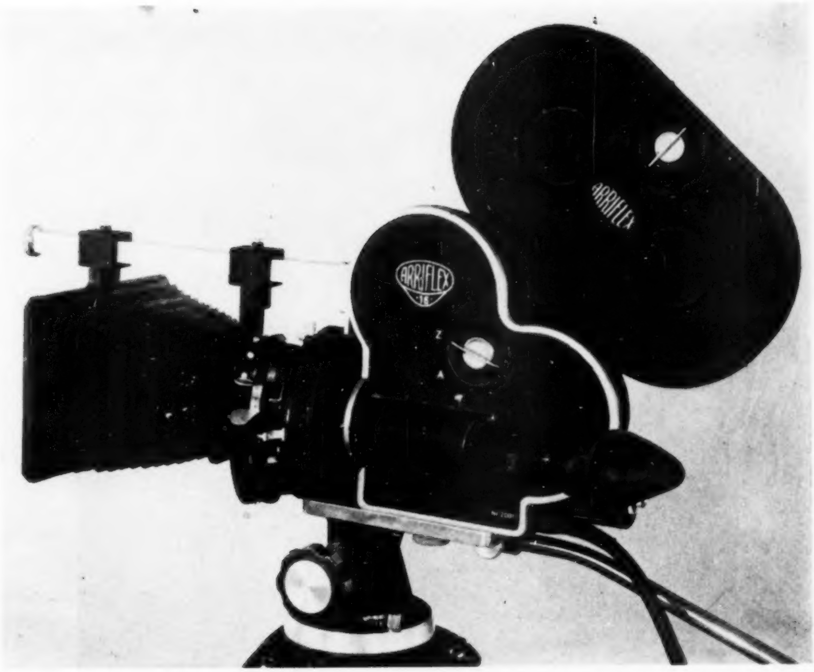

Fig. 1. The Arriflex 16mm motion picture camera.

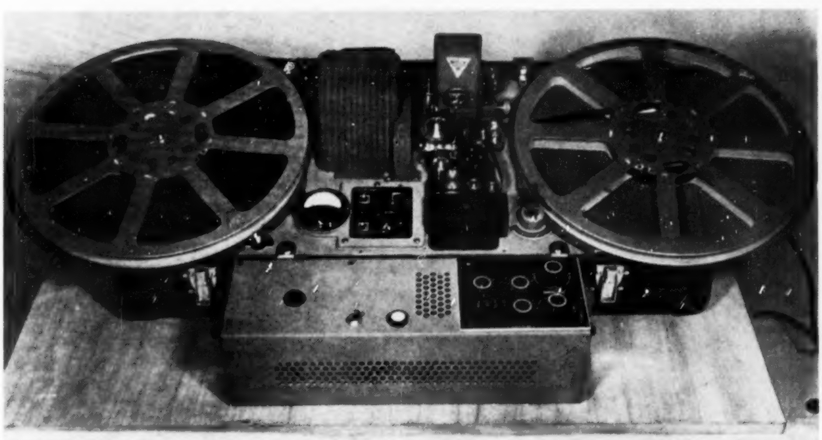

Fig. 2. The Lytax horizontal 16mm sound and film projector.

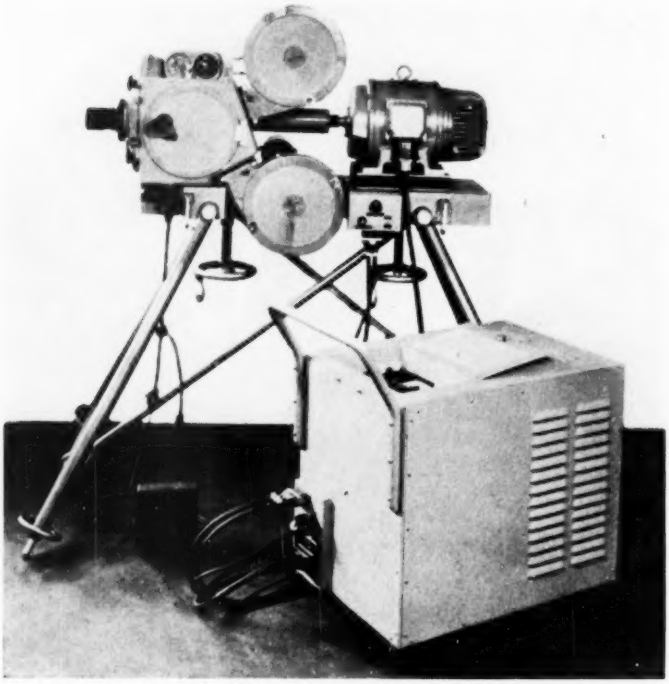

Fig. 3. The Askania Model 4123 high-speed camera and motor control box.

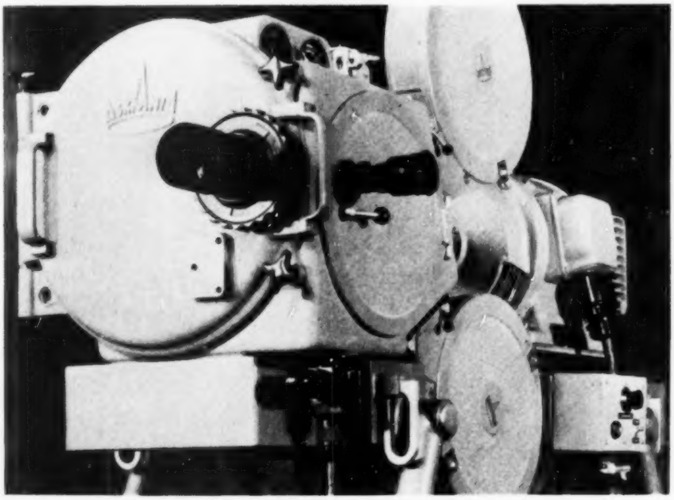

Fig. 4. The Askania Model 4123 high-speed camera.

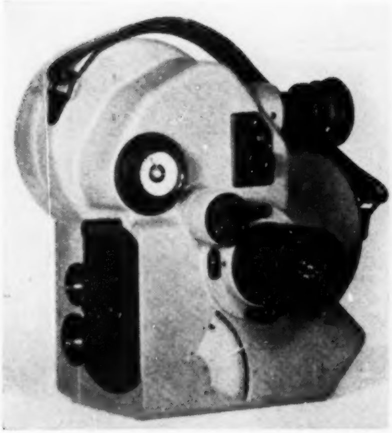

Fig. 5. The Rotax high-speed camera, showing its motor side.

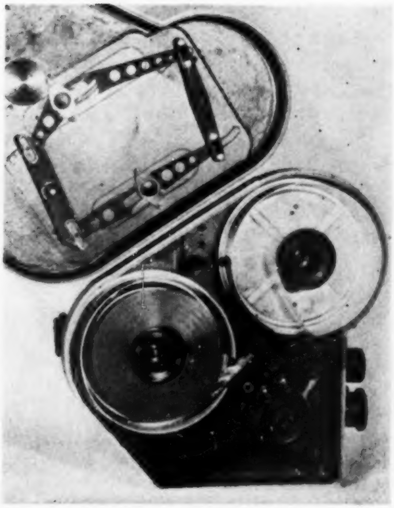

Fig. 6. The Rotax high-speed camera, showing film threading.

High-Speed Photography

During 1952 the Askania factory in Berlin resumed delivery of high-speed cameras. Their large Model No. 4123, illustrated in Figs. 3 and 4, takes up to 2000 frames/sec, and the small hand model Rotax, illustrated in Figs. 5 and 6, takes up to 500 frames/sec. Both of these cameras are again in regular production for industrial research. Optical compensation in the Model No. 4123 is provided by a rotating lens disk. A 16-lens disk, producing frames 18 mm × 24 mm, is used for speeds up to 1000 frames/sec. For speeds up to 2000 frames/sec a 32-lens disk is used, producing frames 9 mm × 24 mm. Optical compensation remains constant at higher or lower picture speeds. The camera drive consists of an electronically powered d-c motor with excellent regulation regardless of the load.

The Rotax, or hand model, slow-motion camera takes pictures up to 500 frames/sec, 18 mm × 24 mm in size. Its light weight enables the taking of pictures at long focal lengths without support, an advantage which up to now no other camera of such high frame frequency has offered. Since the object can be kept in view while photographing with the Rotax camera, flying objects may be followed and photographed with ease and aerial photography is possible without special installation or mounting. The quality of the picture approximates that of normal motion-picture film. Both of these high-speed cameras are equipped with time recording devices which expose light flashes on the edge of the film at 1/100-sec intervals. These markings are used to establish the frame rate during exposure.

35mm Projection

Standard film projectors are now being produced in Germany by a number of firms. Askania manufactures a new projector called the A.P. 12 (Fig. 7) in which the motor drive belt consists of four cables. The motor is so designed that the four cables are stretched equally over the drive wheel of the windup friction gear to drive the mechanisms in the projector head (Fig. 8). It is claimed that this device considerably reduces the wear on all parts. The shutter is a

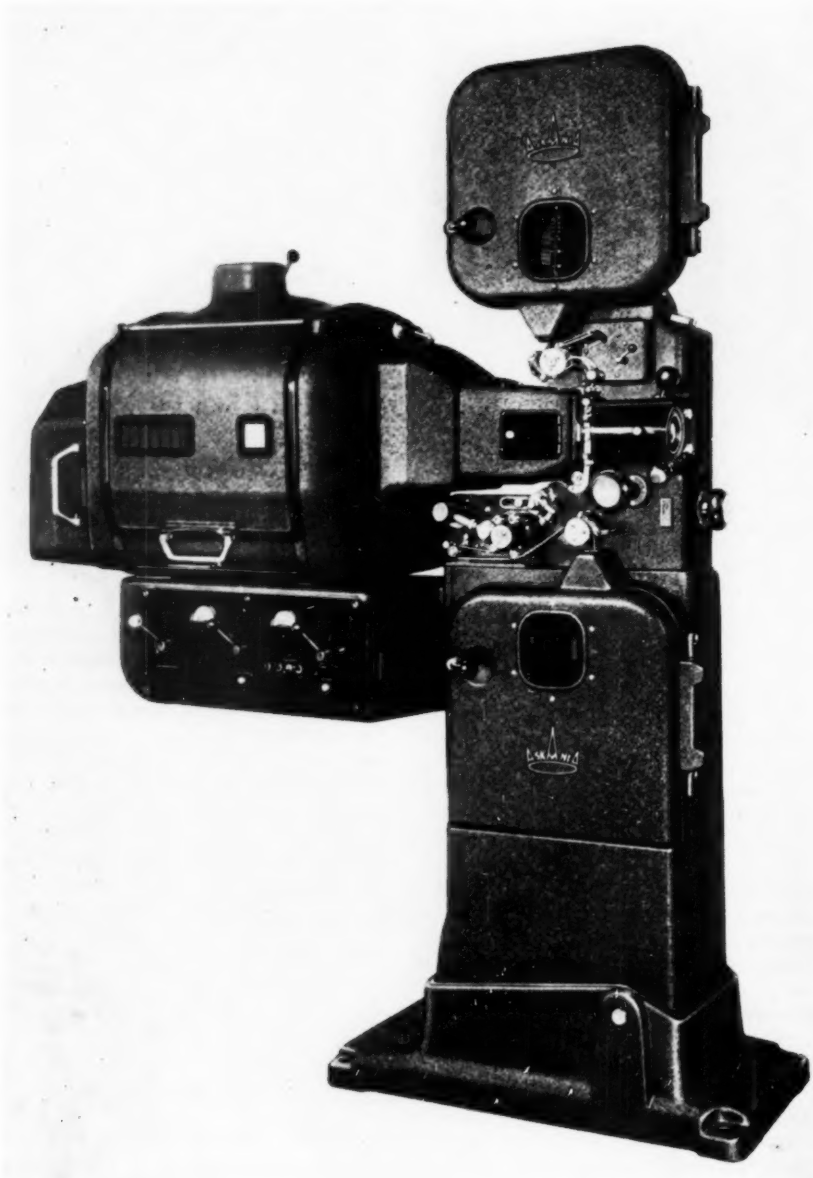

Fig. 7. The Askania 35mm film projector A.P. 12.

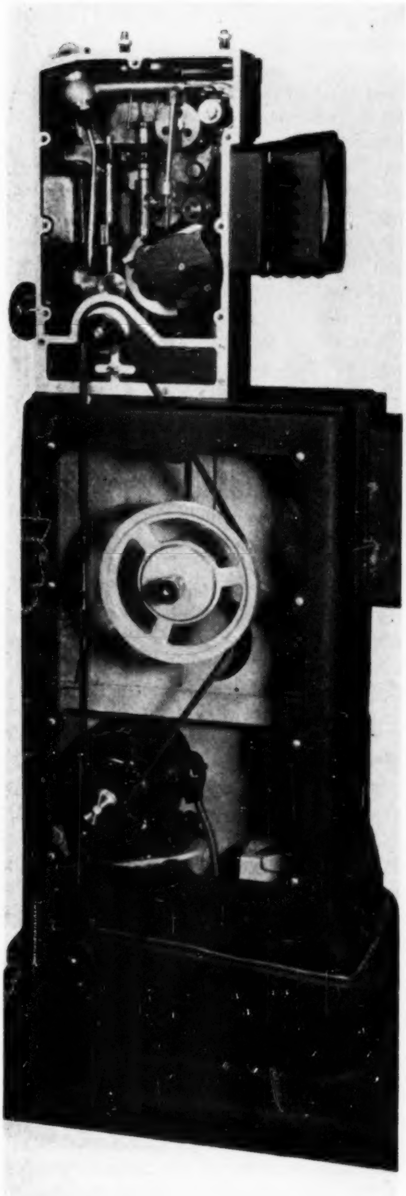

Fig. 8. The Askania projector A.P. 12, showing multi-drive mechanism.

conical diaphragm which provides 30% more illumination than can be attained with drum diaphragms and 14% more than can be attained with disk diaphragms. Askania has announced that it is about to bring out a less expensive model of the A.P. 12.[4]

Eugen Bauer, Stuttgart-Canstatt, is now producing a new projector, the B12.

Frieseke & Hoepfner, of Erlangen-Bruck, has the F.H.66 projector, of which an inexpensive model, the F.H.77, was put on the market at the end of the year.

Zeiss-Ikon, at its new plant in Kiel-Wik, has brought out a new high-performance projector, the Ernemann X, distinguished by a special water-cooling system and a double blower. One of its unusual features is the vertical driving motor axis.[5]

Color

1952 was notable for an increased effort on the part of processing laboratories to achieve satisfactory processing of multi-emulsion films. Color film was produced on a large scale by Agfa at Leverkusen, and color film made by the Agfa color process is now increasingly seen in German theaters.

Gevacolor, high-quality negative and positive color films manufactured by the Belgium firm of Gevaert, are also in regular use in Germany. The color-film developing machine, illustrated in Fig. 9, is specially designed by the firm of Arnold & Richter for processing Agfa color and Gevacolor positive and negative film. This machine can handle approximately 500 meters/hour. All film spools are constructed of special plastic material that is photochemically constant. The film-drive mechanism can be smoothly regulated to the desired speed. The tanks are constructed of plastic material (Vinidur) that is photochemically constant and has good heat-insulating quality. In each chemical bath, provision is made for the liquid to be sprayed against the film's surface,

washing is usually carried out by spray action, and bleaching fluid is applied by jet. The film is vacuum dried. The circulatory pumps are also made of photochemically constant plastic. Washing compartments are provided with electromagnetic devices for synchronizing the movement of the film and the application of the fluid.

Sound Recording

An important development during 1952 was that of the Magneton sound recording and synchronization system now used in Germany almost exclusively.

Klangfilm-Siemens and William Albrecht, both of Berlin, have been especially active in the field of magnetic sound recording and reproducing. Among magnetic sound recorders, Albrecht has a new five-strip tape recorder in which each unit may be used for recording or reproducing. Reverse synchronous operation of all five recording units is possible at normal speed and each tape can be rewound individually at twenty times normal speed. Each unit is equipped with a control switch which automatically stops operation in case of tape breakage or when the tape has run out.

Klangfilm-Siemens is also continuing to produce its own well-known Magnetocord instruments, details of which have been previously published.

At the beginning of the year, Arnold & Richter brought out a single-tape instrument for either magnetic or photographic sound which can be used for 35mm, $17\frac{1}{2}$mm, or, by changing the spools, for 16mm film.[6]

Lighting

In the field of lighting, Arnold & Richter brought out a new arc lamp using three carbons.[7] It is available for 80- to 100-amp and for 160- to 200-amp operation, and is designed for operation with minimum noise. No motor is used to feed the carbons which are so placed (two positive and one negative) as to stabilize the arc.

In the field of projection lamps, Zeiss-Ikon has developed the so-called honeycomb condenser which by its structure achieves a high degree of uniformity in the lighting of the picture area and is relatively insensitive to oscillations of the light arc. Descriptions of this system have appeared in *International Projectionist*.[8]

During the winter of 1951–52, the firm of Strasser & Deltschaft, Berlin-Wilmersdorf, brought out a high-intensity 80-amp arc lamp, the "Junior." This lamp has a simple fully automatic single-motor system which has made it popular for studio use. The adjustable motor, which is enclosed, is noiseless and slow-running. By means of an ingenious cylindrical drive mechanism it rotates and feeds the positive carbon at the same time.

New carbons for motion-picture lighting systems were put on the market by Ringsdorff-Werke GmbH. It is claimed that these carbons have quieter burning characteristics and provide a closer spectral approximation to daylight.

Miscellaneous

During the year under review the "Institute for Film and Picture in Science and Education," of Göttingen, published descriptions of some noteworthy experiments made at the Institute with an Askania Z camera and a stereoscopic lens placed in front of the camera lens.[9]

The double X-ray camera developed by Dr. Metzner and Dr. Bock in Berlin also attracted attention. This equipment includes two cameras coupled together so as to operate alternately. While the film is moving in one camera exposure takes place in the other. Both film strips thus carry pictures spaced at intervals equal to half the time consumed in the shift from one frame to the next.[10]

The firm of Bauer, Stuttgart, produced film reproduction equipment for television film broadcasts made by Fernseh

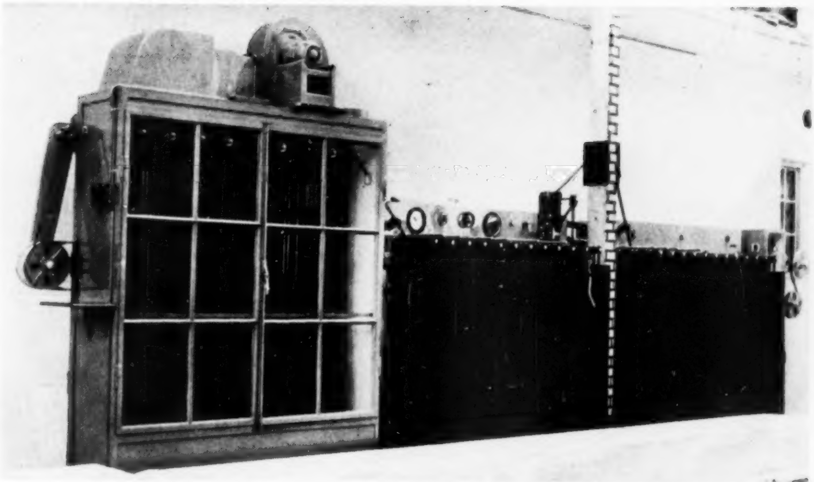

Fig. 9. The Arnold & Richter color-film developing machine.

GmbH (Television Inc.), using systems established by the same firm.

During the past year, efforts were made by motion-picture technicians, under the leadership of the German Society of Motion Picture Technicians, to raise the standard of German film making. Systematic experiments were conducted by Bavaria Filmkunst on the analysis and removal of sources of disturbance affecting studio sound recording.[11] A joint experiment was carried out during the year by German laboratories in which negatives exposed under identical conditions were sent to all laboratories for developing and printing. The results were exchanged for comparison and study of the techniques used by each establishment. Further joint experiments of this nature are in progress.[12]

A well received new test film No. 4A was brought out by the German Society of Motion Picture Technicians.[13] Other new test films are in preparation, including some on 16mm film.

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2. *Ibid.*, pp. 10–11, Jan. 1952.
3. *Ibid.*, pp. 58–59, Mar. 1952.
4. *Ibid.*, p. 60, Feb. 1953.
5. *Ibid.*, p. 265, Nov. 1952.
6. *Ibid.*, p. 20, Jan. 1952.
7. *Ibid.*, p. 43, Feb. 1952.
8. A. R. Schultze, "The Honeycomb Condenser Lamp Optics," *Int. Proj.*, *26, IV:* pp. 5–6, Apr. 1951.
9. *Kinotechnik*, pp. 36–39, Feb. 1952.
10. *Ibid.*, pp. 55–56, Mar. 1952.
11. *Ibid.*, pp. 56–57, Mar. 1952; pp. 86–87, Apr. 1952.
12. *Ibid.*, pp. 194–197, Aug. 1952.
13. *Ibid.*, pp. 260–261, Nov. 1952.

Visual Examination of 16mm Photographic Sound Tracks

By O. L. GOBLE

VISUAL INSPECTION of the sound track on 16mm film can yield much valuable information, particularly with regard to the presence of processing faults. To enable large quantities of film to be inspected, a simple type of projection microscope has been specially constructed.

A magnified image of the sound track (×36 diameters) on a ground-glass screen can be viewed without eyestrain while the film moves through the gate. A graticule in contact with the screen enables rapid dimensional checks to be made, if necessary while the film is in motion.

The instrument has been in service for a considerable time, and it has been found that after a little experience an operator can examine considerable footage without fatigue.

Description of Instrument

The instrument is built on a wooden case, approximately 3 ft 6 in. high, which stands on the floor (Fig. 1). The film is fed manually through a gate which is located on top of the case. An image of the sound track, about 4 in. wide, is thrown onto the inclined ground-glass screen.

Figure 2 is a schematic diagram showing the layout of the optics, and is largely self-explanatory. The light source is a standard 10-v, 7.5-amp, exciter lamp. The projection lens is an $f/3.5$ photographic objective, having a focal length of 2 in.

The enclosed mirror at the base is mounted so that it can be adjusted for final alignment.

Figure 3 is a photograph of the ground-glass screen, showing the image of the sound track and the graticule. Distances from the film edge are shown in thousandths of an inch, while horizontal lines indicate the dimensional limits according to accepted standards. The film gate is adjustable so that the edge of the film can be lined up with the graticule, and it is important in the design of the gate that the sound-track edge of the film should not weave as the film moves.

This instrument was built only as an experimental model from readily available components; a new instrument based on the same principle, with many improvements, is at present being designed.

Communication No. 1560A from the Kodak Research Laboratories, Rochester 4, N.Y., by O. L. Goble, Research Laboratories, Kodak Australasia (Pty.) Ltd., Abbotsford 9, Melbourne, Victoria, Australia.
(This paper was received on April 24, 1953.)

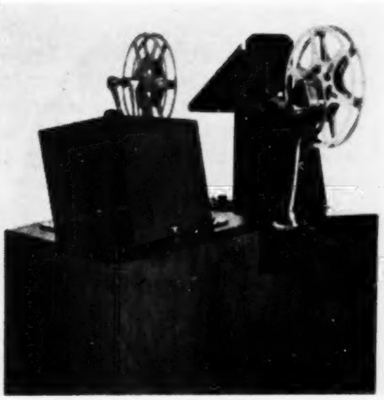

Fig. 1. Simple type of projection microscope.

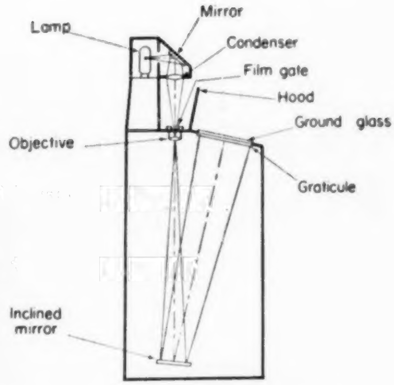

Fig. 2. Schematic diagram showing the layout of the optics.

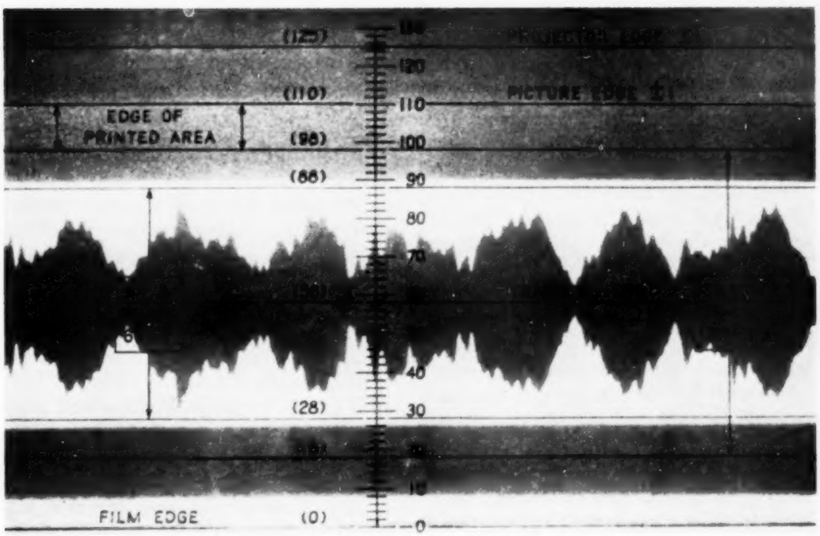

Fig. 3. Photograph of the ground-glass screen showing the image of the sound track and the graticule.

Processing 16mm Color Film With a Silver Sound Track

By JOHN FRITZEN

A description is given of the approach and final solution to the development of a silver sound track on 16mm Cinecolor for use with the lead sulfide photocell.

WITH THE ADVENT of the development of the lead sulfide photoresistive cell for use in sound film projectors, the need for a sound track opaque to the far infrared arose.[1,2,3] This cell has excellent sound reproduction characteristics for use in the 16mm field and has been adopted in one of the JAN 16mm projectors. As described in the literature, the cell has the greatest portion of its response in the region from 1.0 to 3.0 μ, as contrasted to the normal photoemissive cell, which is sensitive from 0.5 to 1.0 μ. The silver sound track has been found eminently satisfactory for use in this application and became the object of our search. As has been described earlier, the Cinecolor process normally uses a toned track for projection with photoemissive cells.[4] This track is transparent in the area of maximum sensitivity of the lead sulfide cell. Much of the Cinecolor two-color release was reduced to 16mm for the military services, to be used on the JAN projectors, hence this release had to be with a silver sound track.

The problem resolved itself into several parts. First, to determine the order of film processing: the fixing, toning and dyeing stages are set. Second, a means to obtain a track of adequate density and gamma characteristics: the Cinecolor process normally requires the film to be developed to a relatively low black-and-white gamma since the dye and toning steps will give a sufficient conversion factor to obtain the desired screen effect. This consideration would normally indicate a drastic change in the sound negative, which is not feasible due to printing problems and the characteristics of the sound negative development. As a part of the investigation consideration was given to the application and subsequent removal of resists. The handling, necessary precision of application, and removal difficulties precluded their use in the present solution for a two-color system. Similarly, an investigation was made into the possible redevelopment or intensification of the toned or dye mordanted sound track. This was also rejected due to the inherent limitation of

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the initial development gamma. A third part of the problem, but no less acute than the preceding ones, was to integrate the solution into the existing equipment with a minimum amount of modification. The present Cinecolor process is adapted to handle either 35mm or double 16mm and it was desirable to maintain this flexibility.

The final approach to the problem was to attempt a modification of the three-color SupercineColor process to produce a two-color Cinecolor release with silver sound track. This process has been described in detail by Gundelfinger.[5] The process is briefly described here as follows: The initial exposure and development of a black-and-white image on each side of duplitized film is followed by toning, the regeneration of a light-sensitive material and drying. The third image is printed in register and developed, with the requisite bleaching, dyeing and fixing steps following in the proper order. From this procedure the resultant sound track is the same color as the cyan component of the picture, i.e., ferriferrocyanide. By the use of this process with a modification of the second development stage and an appropriate dye, the problem was easily resolved. In effect, the modification was to print the sound instead of the third image of the three-color process, and keep it a silver image instead of dyeing it. Although an extra process-machine step was involved over normal two-color production, only minor changes in the machines were required, and for two-color the number of printing steps were the same. With the use of a higher gamma developer for the sound several of the above sections of the problem were eliminated, namely the resist application and redevelopment portions. The use of a higher gamma second developer resulted in easy processing of two-color 16mm release with a silver sound track. The prevention of attack by bleaching and dyeing is easily obtained as a result of the design of the process machines and past experience in the processing of film by flotation.

Cross and intermodulation tests indicate that while in some cases re-recording might be desirable, it is not a general requisite. The resulting product from this processing method and the use of an optical sound printer is very good.

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Matching Densitometry to Production

By HOWARD T. RAFFETY

Densitometry at Cinecolor matches use as closely as possible. To this end, densitometry of material to be used on optical printers is on a "specular densitometer," and densitometry of sound tracks is on a "sound reproducer densitometer." This paper describes these two densitometers.

The "Callier Q" factor of silver images on film is a very indeterminate quantity. Because it changes with the type of film, development conditions, density and gamma, it is impossible to calculate a factor that can be applied to diffuse densitometry and have it match any particular specular use.

Cinecolor has taken the attitude that in order to have densitometry represent as completely as possible the actual film-printing operation, the "Q" factor must be by-passed entirely, and densitometry set up on the basis that the density reading match as closely as possible the density which the raw stock will see during printing.

Specular Densitometer

The specular densitometer in use at Cinecolor is a Welch Densichron Transmission Densitometer converted to read specular densities. In the original Welch densitometer the design of the light-collecting device which feeds the photosensitive surface is such that all light entering the collector falls onto the phototube, thus reading diffuse density. This densitometer consists of two units: the Welch Densichron Transmission Density Unit #2150D and the Densichron #2150 (see Fig. 1).

The Cinecolor modified model consists of these same two units with the addition of a film-handling gate. The light-collecting attachment was changed (see Fig. 2). The plastic integrating bar was removed and a collimating device was inserted in its place. This collimator consists of two plates about 1 in. apart with the faces parallel and with $\frac{1}{8}$-in. holes drilled in them. The collector was mounted about an inch away from the track where the film sample is placed to be densitometered. The densities obtained in this way are a close approximation of specular densities as seen by an Acme optical printer. This modification of the light-collecting attach-

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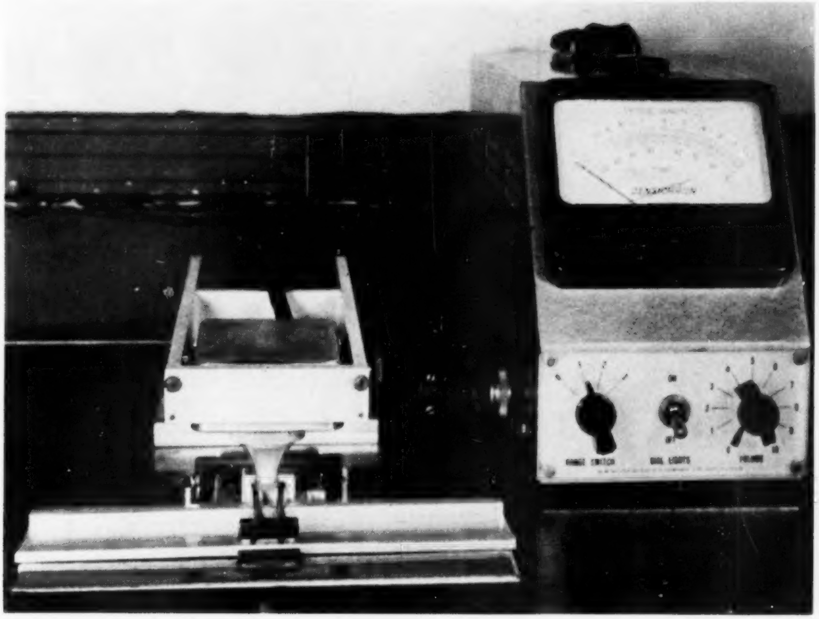

Fig. 1. Welch Densichron Transmission Density Unit #2150D and Densichron #2150.

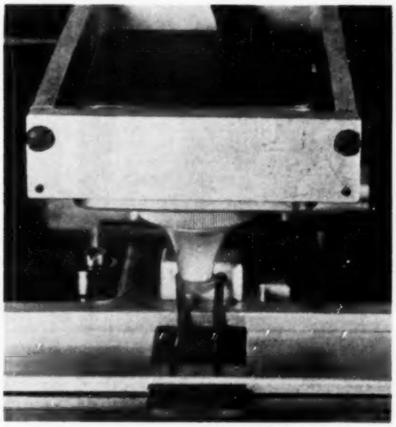

Fig. 2. Close-up view of Welch Densichron Transmission Density Unit #2150D showing film-handling gate and collimater.

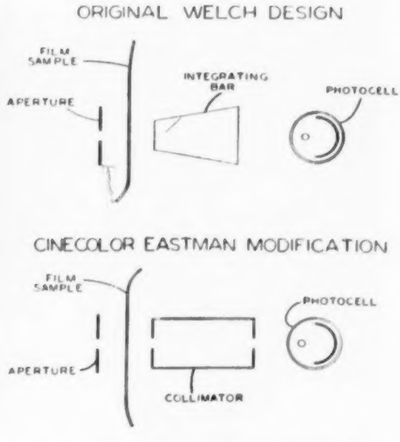

Fig. 3. Comparison of original Welch design and the Cinecolor-Eastman modification.

Fig. 4. RCA Sound Reproducer showing interrupter wheel attachment.

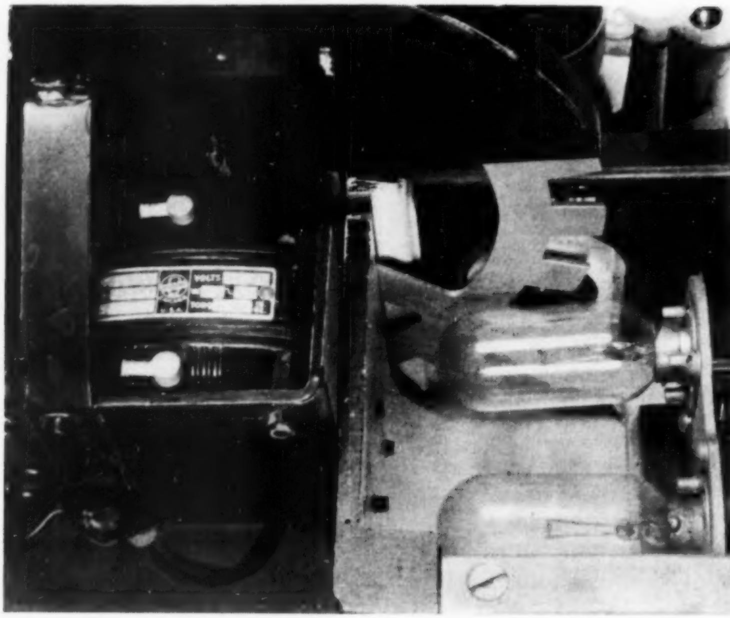

Fig. 5. Close-up view of interrupter wheel attachment.

ment was the result of an idea originated jointly by Vaughn Shaner of Eastman Kodak and Harry Brueggemann of Cinecolor. The original Welch design and the Cinecolor-Eastman modification are shown in Fig. 3.

Sound Reproducer Densitometer

The sound analyzer in operation at Cinecolor is standard RCA 35mm sound film reproducing and measuring equipment. The light from a 10-v exciter lamp passes through a condenser lens onto an RCA #868 phototube. It was desirable to obtain density readings that would match as closely as possible the density of the sound track as seen by the sound projector. Therefore an attachment was made to convert the sound reproducer to a densitometer (see Fig. 4). The original idea and design for this attachment were made by Harry Brueggemann of Cinecolor. A metal disc $7\frac{1}{2}$ in. in diameter was notched with $\frac{1}{2}$-in. teeth at $\frac{1}{2}$-in. intervals. It is driven by a small synchronous motor which runs at 1800 rpm on a 60-cycle supply line and it interrupts the light beam 660 times/sec (see Fig. 5).

With no film in the sound projector and the interrupter wheel in operation, the amplifier gain is adjusted to a nominal "zero" level on the standard RCA Volume Indicator MI 11265. Then introducing a film, such as a gamma strip, in the sound-track area, will cause a drop in volume of the 660-cycle note. This volume change is read in decibels on the panel, and converted to density by the equivalence 1 db = 0.05 density.

Transmission Densitometer for Color Films

By K. G. MACLEISH

The need for unification of density measurements made in numerous and widely separated laboratories led to the development of the Eastman Electronic Densitometer, Type 31A. This densitometer reads diffuse densities of color films from 0.0 to 4.1 through narrow-band color filters, with a standard deviation of ±1% among different instruments. The construction and performance of the densitometer are described.

THE BEHAVIOR of a photographic image in an optical system, such as a projector or a printer, can be described in terms of the fraction of the incident radiation transmitted by selected portions of the image. In practice it is convenient to use the negative logarithm of this fraction, a number which is referred to as the density of the material. It is well recognized that density, so defined, is not in general a property of the material alone, since its value depends on the optical configuration of the illuminating and receiving systems.[1] Thus different density-measuring instruments, or densitometers, may be quite at variance with one another in their readings on identical samples.

Of the many different types of transmission densitometers employed by the Eastman Kodak Company, each is considered more or less satisfactory for the specific kinds of measurement to which it is adapted. The need, however, for coordination of sensitometric results throughout the organization has made it imperative that each laboratory have available a precision densitometer of some one type, to which all measurements may be referred. Moreover, it is highly desirable that this standard instrument be versatile, sensitive, rugged, and generally suited for use both in research and in process control. None of the densitometers available prior to 1948 seemed to meet all these requirements; the decision was therefore made to undertake the development of a new densitometer having the desired characteristics. The resulting instrument, which is the subject of this paper, has been designated as the Eastman Electronic Densitometer, Type 31A.

To date, about seventy Type 31A densitometers have been placed in service in Kodak plants and laboratories

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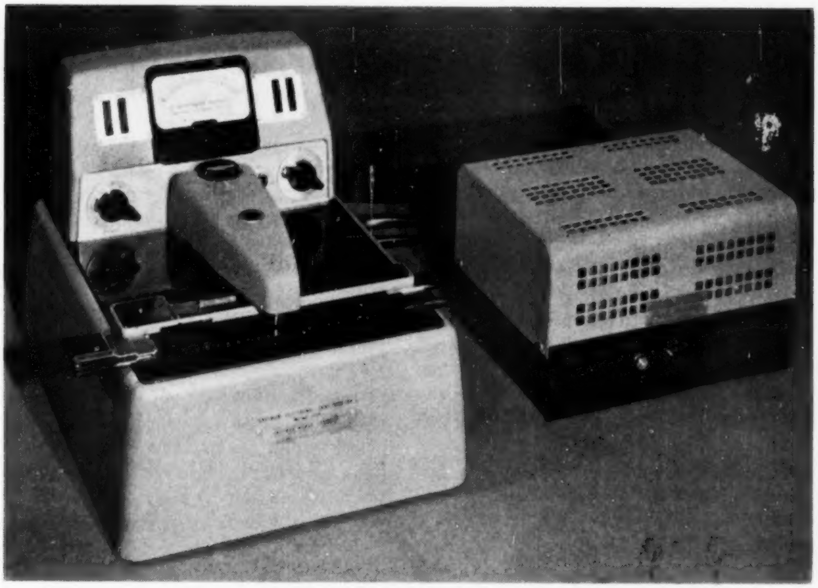

Fig. 1. Type 31A densitometer with strip holder and indexing mechanism. Separately mounted amplifier at right.

throughout the world, with very encouraging results.

Requirements

The functional requirements decided upon for the new densitometer were as follows:

1. Measurement of transmission density in narrow spectral regions defined by interchangeable color filters.
2. A direct-reading range of 0 to 4.
3. Measurement of integral density, that is, spectral density of the sample as a whole. Analytical densities, or the densities of individual dye components, can be deduced by a transformation process from integral densities measured at three wavelengths.[2]
4. Conformance of the readings, on all types of samples, with American Standard diffuse density.[3] Briefly, this means illumination of the sample with nearly collimated light and collection of light emerging at all angles.
5. Adaptability to the widest possible range of uses, including graphic-arts applications, measurements on photographic plates, and rapid stepwise positioning and reading of sensitometric strips.
6. Freedom from drift and instability due to all causes, including line-voltage variations.

The necessity of measuring spectral densities up to 4 demands a higher instrument sensitivity than is immediately apparent, because of the necessarily low total transmittance of suitable color filters. A dye image may, for example, have a density of 4 at the wavelength of measurement and yet transmit quite freely over broad bands in the visible and infrared. In such cases, only a color filter having extremely high density outside the passband can attenuate sufficiently to prevent contamination of the measured flux. Narrow-band color filters having acceptable performance, such

as those cited below, may be expected to absorb as much as 99.8% of the available light, in terms of system response. In comparison, then, with a densitometer designed to read only black-and-white densities, the sensitivity of a densitometer for color materials must be higher by a factor of as much as 500.

Description

Figure 1 shows the Type 31A densitometer with its separately housed amplifier unit. The units are connected by two 5-ft cables, one carrying signal leads and the other containing power and control connections. The separated construction allows the amplifier to be placed in an out-of-the-way location where it need be reached only for servicing. All operator's controls on the densitometer proper are mounted in a superstructure above the sample plane, since it is sometimes convenient to have the instrument flush-mounted in a cut-out table top.

In the center of the superstructure is the indicating meter, which has an approximately uniform density scale graduated in 0.02 divisions from 0.00 to 1.10. Four density ranges — 0 to 1, 1 to 2, 2 to 3 and 3 to 4 — are covered by the one meter scale and by the four-position range switch at the lower left of the panel. Overlap between successive ranges is provided by the extra 0.1 density range at the end of the meter scale.

At the lower right of the panel is the color switch for selection among eight different color filters. The filters are normally used in sets of three — red, green and blue — but provision of eight filter positions allows quick selection of additional filters, and also facilitates the use of the instrument for abridged spectrophotometry.

Beside the indicating meter are four zero-adjustment knobs, mounted edgewise behind panel slots, for setting the meter to zero density with the sample removed. A separate zero adjustment is connected to the circuit for each of four positions of the color switch; this arrangement makes it possible to read a sample through four filters in succession without removing the sample to reset the zero with each filter. The remaining four filter positions utilize the same set of zero adjustments.

From the superstructure extends a hinged reading arm containing the measuring phototube. The arm has sufficient span for reading the center of a sample 20 in. wide. The weight of the arm is counterbalanced by a spring at the hinge; an additional toggle-action spring holds the arm in the lowered position for reading, but causes it to remain up when lifted for inspection or insertion of a sample. On the top surface of the arm, near the back, is a graduated knob for adjustment of a stop that limits the downward travel of the arm. This control brings the window of the measuring phototube into contact with the surface of the sample when the arm is lowered, as required for accurate measurement of diffusing samples, but prevents the weight of the arm from exerting pressure. The sample may then, if desired, be moved about without raising the reading arm; moreover the position of the phototube remains unchanged when the sample is removed for zeroing. The latter condition is a necessity when thick samples, such as photographic plates, are to be read.

Figure 1 shows the densitometer equipped with an accessory strip-reading attachment comprising a strip holder and a spring-driven indexing mechanism. This equipment accelerates the routine measurement of standard 16mm and 35mm sensitometric strips having up to 21 steps. The strip to be read is first slid endwise into the holder (which can be disengaged from the indexing mechanism and handled separately) and pinned in position by release of the film clamp at the lefthand end. The holder is then engaged with the indexing mechanism and moved to the right against a stop. This action winds the spring and brings

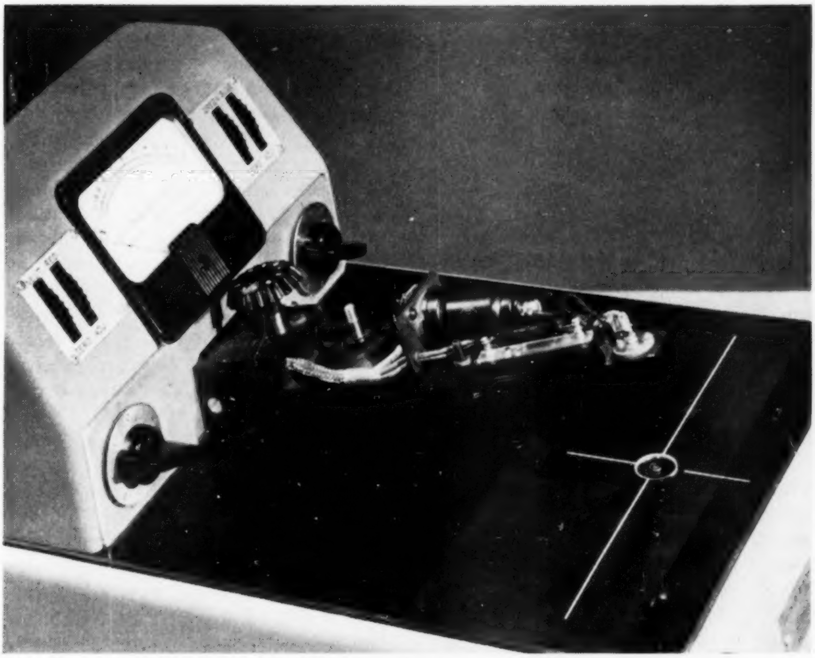

Fig. 2. View with reading-arm cover removed.

the first step into reading position. Each actuation of a lever on the mechanism moves the holder one step to the left, in the manner of a typewriter carriage. The number of the step being read is indicated by a scale along the front edge of the holder. For sensitometric procedures in which only certain selected steps are read on each strip, the indexing mechanism will accommodate a special strip holder that stops only at the desired positions.

In Fig. 2 the cover of the reading arm has been removed to show the type 1P42 measuring phototube, its load resistor, and a cathode-follower amplifier stage. The figure also shows, in the sample plane below the phototube, a transparent circular disk containing an opaque insert. The optical system of the densitometer projects a uniform spot of light on the insert from below. An aperture at the center defines the size and shape of the measured area on the sample. When the reading arm is raised, an auxiliary lamp comes on and brightly illuminates a white background surface, which is visible to the operator through the transparent disk and through the defining aperture. This viewing arrangement is an invaluable aid in finding the exact spot on the sample that is to be read, particularly when the density is high. The transparent disk is interchangeable with others having defining apertures of different sizes and shapes. The largest area that can be measured is, of course, determined by the size of the phototube window, which is 5 mm in diameter. The aperture normally used is 5 mm in diameter. Much smaller apertures can be employed, at the expense of a reduction in the usable density range.

Figure 3 is a view of the densitometer with the top raised for access to the optical system. At the left is a brace mechanism that counterbalances the weight of the hinged top and locks the top in either a half-open or a fully open position.

Optical System

The optical system of the densitometer is shown, approximately to scale, in Fig. 4. For clarity, a part of the system is shown as if turned 90° from its actual position; otherwise, the figure is a top view. The sample is illuminated from below by light that has passed successively through lens A, a rotating light chopper (modulator), a heat-absorbing glass, a color filter, a neutral filter used in shifting the meter range, lens B, and the defining aperture in contact with the sample.

Since the readings are to conform to the American Standard for diffuse density, all of the light emerging from the sample must be collected, or at least equally weighed, in the receiving system. For this purpose, advantage is taken of the structure of the miniature, end-on 1P42 phototube. The sensitive surface of this tube is coated on the inside of a glass window that covers one end of the tube. The window, being in close contact with the upper surface of the sample, admits not only the specularly transmitted light but nearly all the scattered light as well. This method of diffuse collection avoids the losses that occur with other arrangements, such as an integrating sphere or a diffusing plate, and therefore gives a higher sensitivity. The phototubes used are stringently selected for high sensitivity, low drift, and normal spectral response.

The light source is a blower-cooled 100-w projection lamp operated at line voltage. A spherical mirror behind the lamp forms a filament image that fills the spaces between the filament coils and nearly doubles the available light. Lenses A and B together form an optical relay; that is, lens A images the lamp filament on lens B, which in turn images the aperture of lens A on the under surface of the sample. Since the circular aperture of lens A is nearly uniformly illuminated by the lamp, its image at the sample is a nearly uniform circular spot. The spot is slightly larger than the 5-mm window of the measuring phototube. The aperture of lens B is stopped down until all the rays strike the sample within 10° of normal incidence. A wider cone of illumination would give more intensity at the sample and therefore higher sensitivity, at the expense of impaired conformance with American Standard diffuse density.

A second 1P42 phototube is employed in a comparison system which removes the effects of line-voltage variation and amplifier drift, in a manner to be described subsequently. This phototube receives an amount of light that is independent of the sample density but that varies with the intensity of the lamp. A filament image is formed at the comparison phototube by lenses C and D and two small mirrors. The illumination in the image can be adjusted by means of an iris diaphragm at lens D; this control has the effect of a wide-range zero adjustment.

The light chopper, shown in Fig. 5, is made of photographic film and is driven by an 1800-rpm synchronous motor. The three opaque areas at the outside of the chopper interrupt the measuring beam at a frequency of 90 cycles/sec. At a smaller radius is a ring containing 160 opaque areas, which interrupt the comparison beam at 4800 cycles/sec. The resulting 90- and 4800-cycle electrical signals from the phototubes are combined and amplified as a single composite signal. It is worth noting that, in a system using chopped light and an a-c amplifier, phototube dark current is ordinarily of little consequence since its direct component is not amplified.

The eight color filters are mounted in Kodak Adapter Rings which clip onto a

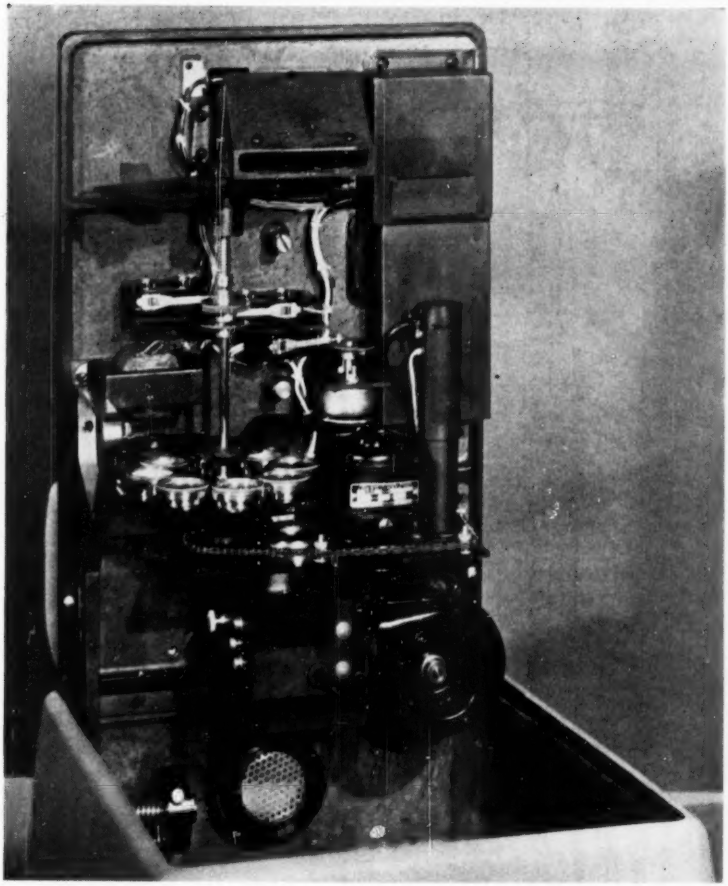

Fig. 3. Densitometer with top raised to servicing position.

rotatable filter wheel. The wheel is connected through a sprocket chain to the color switch on the control panel. A roller detent mechanism at the wheel positions each filter accurately in the measuring beam.

Originally the most satisfactory color filters available were cemented combinations of glass and gelatin elements having half-intensity bandwidths of the order of 30 mμ and effective transmittances of about 0.4%. Recent advances in the techniques of manufacturing interference filters of the Fabry-Perot type have led to the development of excellent densitometer filters made up of matched pairs of interference filters in combination with gelatin elements for absorbing the unused interference orders. A description of these filters has been published by S. A. Powers and E. K. Letzer.[4] Figure 6 shows the characteristics of a set of interference-type filters peaking at 436, 546 and 644 mμ, in conformance with a recently published Standard,[5] and having half-intensity bandwidths of 10 mμ or

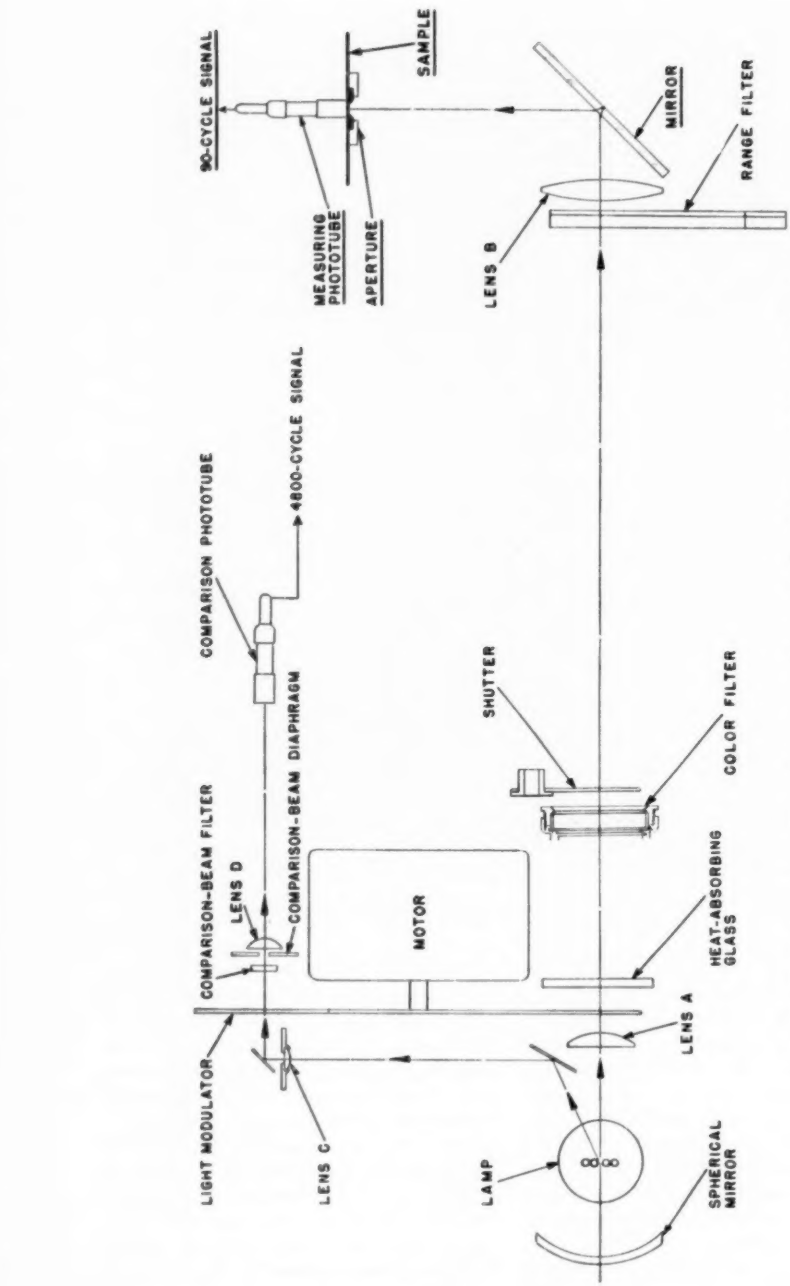

Fig. 4. Optical system. Top view except for underlined items, which are side view.

Fig. 5. Light chopper.

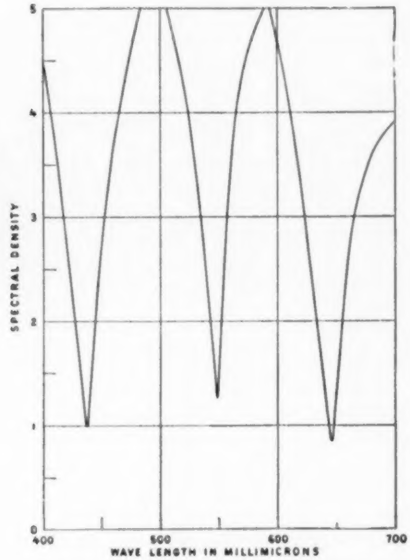

Fig. 6. Spectral characteristics of interference-type narrowband filters.

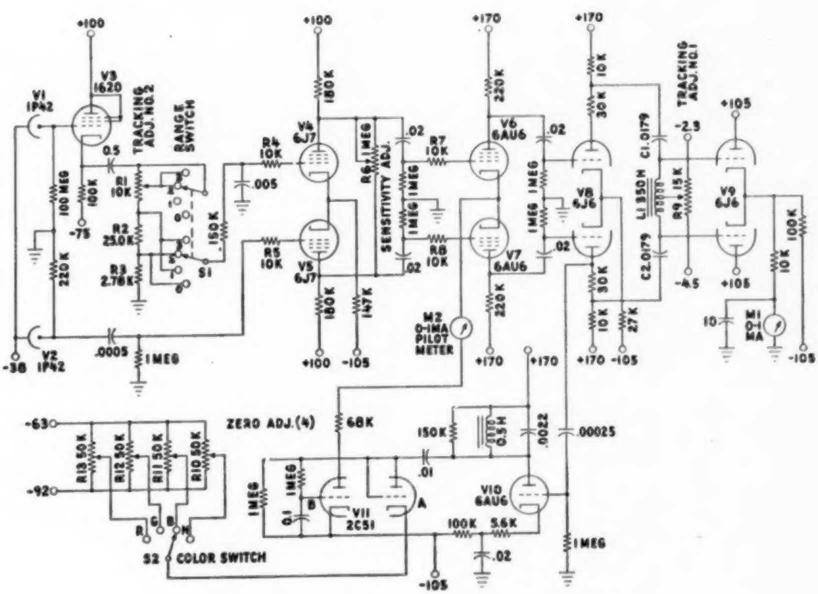

Fig. 7. Simplified schematic diagram of amplifier.

less. The total effective transmittance of these filters is about 0.2%. Their stability, narrow bandwidth, and extremely high shoulder density make them ideal for any densitometer possessing adequate sensitivity. Both glass-gelatin and interference filters are currently used in the Type 31A densitometers. During 1953 all the glass-gelatin narrow-band filters are to be replaced with interference filters having the characteristics shown in Fig. 6.

Amplifier

Figure 7 is a simplified schematic diagram of the electronic circuit. The power supply, which is omitted from the figure, is a conventional transformer-rectifier combination with VR tubes for regulation of those voltages that are critical. Both positive and negative voltages are made available by grounding the supply at an intermediate point.

The measuring phototube, V1, produces at its anode a 90-cycle signal that varies with the transmittance of the sample. This signal passes first through a cathode-follower stage, tube V3, located in the reading arm close to the phototube. The cathode follower drives a precision 10:1 attenuator, resistors R2 and R3, which is used for calibration and for selecting the four density ranges, as described below. The signal is then amplified by three capacitively coupled push-pull stages, tubes V4 through V8. At the output of the third stage is a series-resonant filter composed of coil L1 and capacitors C1 and C2. The filter further amplifies the 90-cycle signal but discriminates against resistor noise, microphonic noise, and the 4800-cycle signal originating in the comparison phototube. A full-wave detector, tube V9, of the infinite-input-impedance type,[6] rectifies the signal for application to the indicating meter, M1. The meter has pole pieces shaped to give an approximately logarithmic deflection, and therefore carries a nearly uniform density scale.

Four resistors, R4, R5, R7 and R8, play an important part in reducing interference from electrical machinery operating near the densitometer. Such interference is frequently observed in high-gain amplifiers and is caused by grid detection of noise bursts containing extremely high frequencies (over 100 mc). Usually the noise enters the amplifier by direct radiation to the grid circuits of the low-level tubes; ordinary shielding and power-line filtering are likely to prove quite ineffective. But, if the noise voltage at each grid is attenuated enough to prevent its driving the grid to conduction, detection does not occur and the amplified noise is by-passed by the plate capacitance. Each of the four resistors forms part of an R-C filter, the capacitance portion of which is the input capacitance of the corresponding tube. The resistors, mounted immediately adjacent to the tube pins, attenuate the high-frequency noise without affecting the normal passband of the amplifier. This simple remedy has proved to be an effective cure for interference from external sources.

If the comparison phototube were not used, the deflection of the indicating meter would depend not only on the sample density but also on the lamp intensity and on the amplifier gain. The lamp intensity reacts to changes in line voltage, and the amplifier gain is affected by drift in any of the three stages. Stable operation does not demand that these variations be removed individually, but requires only that the product of lamp intensity and amplifier gain remain constant. It is the function of the comparison system (tubes V2, V10 and V11) to hold this product at a constant value by automatically controlling the gain of the second amplifier stage, tubes V6 and V7. The 4800-cycle comparison signal from phototube V2 is applied to the input of the amplifier at the grid of tube V5. Through the action of the cathode resistor common to tubes V4 and V5, the

4800-cycle signal is added to the main 90-cycle signal, and the sum is then amplified as a single composite signal. The output of the third stage, tube V8, is applied to a tuned amplifier, tube V10, which isolates the 4800-cycle component. At the plate of tube V10 the signal is proportional to the product of the lamp intensity and the amplifier gain; it is this product that is to be held constant. The signal from tube V10 is compared, in tube V11A, with a stabilized d-c reference voltage. The difference, or error, voltage appears as a negative bias on the grid of tube V11B, which controls the total plate and screen current (and therefore the gain) of tubes V6 and V7. The regulating action is as follows: an increase in the output of tube V10 increases the error voltage, increases the bias on tube V11B, reduces the plate and screen current in tubes V6 and V7, and reduces the amplifier gain to restore the original 4800-cycle signal at tube V10.

Adjustment of the iris diaphragm in the comparison beam changes the 4800-cycle input signal; the automatic gain-control circuit then changes the amplifier gain. This action provides a means of altering the instrument sensitivity over a wide range for various conditions of operation. After such an adjustment, the gain-control circuit is brought back to the middle of its operating range by resetting the gain of the first stage, governed by potentiometer R6. Proper setting of this potentiometer is indicated by the pilot meter, M2, which reads the plate current of tube V11B. The pilot meter is also used in trouble shooting and in a very simple check on the linearity of the amplifier. This check is based on the fact that a slight curvature in the amplifier characteristic causes appreciable "cross talk" between the superimposed 90-cycle and 4800-cycle signals. Any significant nonlinearity, such as might arise from a weak amplifier tube, causes the pilot meter reading to change when a high-density film is placed in the sample position.

Calibration

There are, in effect, three calibration controls in the densitometer: the zero adjustment and two controls designated as tracking adjustments 1 and 2. Correct setting of these controls calibrates the instrument for all types of samples; the proper settings are indicated by the densitometer itself, without reference to external standards. The zero adjustment (actually there are four for different color filters) sets the indicating meter to zero density with the sample removed, and thus insures accuracy at a density of zero. Tracking adjustment 1 removes any instrument error at a density of 1, provided only that the decade attenuator is accurate and that the measuring phototube collects all the transmitted light. Tracking adjustment 2, under these same conditions, removes any instrument error at densities of 2, 3 and 4. The accuracy at intermediate densities depends on three additional factors: the scale calibration of the indicating meter, the linearity of the measuring phototube, and the linearity of the amplifier. The last factor can be checked, as noted earlier, by means of the pilot meter.

The four zero-adjustment potentiometers, R10 through R13, control the d-c reference voltage supplied to the cathode of tube V11A. This voltage determines the 4800-cycle output from tube V10, which in turn establishes the amplifier gain and the density reading with no sample in place. One of the potentiometers is connected to the circuit for each pair of positions of the color switch, S2, which is operated by the same knob that selects the color filters.

Tracking adjustment 1 (potentiometer R9) controls the d-c bias on the grids of the detector tube, V9. Its effect is to introduce an adjustable additive constant into the relationship between the output of the measuring phototube and the current in the indicating meter. The proper setting is the one for which a ten-fold reduction in signal strength,

obtained by switching the decade attenuator, changes the meter reading from 0.00 to 1.00. This setting calibrates the densitometer at a density of 1, since a sample of density 1 likewise gives a ten-fold signal reduction. The calibration so obtained is independent of the linearity of the amplifier and of the accuracy of the meter scale. The procedure for setting the potentiometer consists simply in making the densitometer "track," or agree with itself, in the overlapping region covered by the two lowest density ranges.

The decade attenuator, in addition to serving as an electrical calibration standard, is used for shifting the meter range. In principle, all four ranges could be obtained with an attenuator having four decade steps. Such an arrangement, however, would subject the measuring phototube to an illumination range of 10,000 to 1. If the minimum illumination (at a sample density of 4) were sufficient for good signal-to-noise ratio, the maximum illumination (at zero sample density) would then be high enough to cause drift in all but the most stable types of phototubes. The type 1P42 phototube has been found to be somewhat unstable at high illumination levels. With this phototube, therefore, straight electrical attenuation is not suitable. Alternatively, it is possible to introduce the attenuation purely by optical means, using accurately calibrated filters in the measuring beam. This method reduces the illumination range at the phototube, but poses the equally troublesome problem of constructing accurate, nonselective filters.

In the Type 31A densitometer these difficulties are avoided by combining electrical and optical attenuation in a way that retains the advantages of each. In the measuring beam is mounted a movable two-step filter. The range-switch knob on the panel controls both the decade attenuator and the position of the two-step filter. The filter is essentially a developed photographic plate of which one half is clear and the other half is opaque except for a closely spaced array of small clear dots covering, in all, about 1% of the area. When the filter is moved from one position to the other, the illumination at the sample is changed by a factor of about 100. Neither half of the filter is completely nonselective, owing to selective absorption and reflection in the clear emulsion and in the glass support. Nevertheless, the proportional change in sensitivity due to moving the filter is independent of wavelength, since the clear dots are nonselective relative to the clear half of the filter. The four density ranges are obtained by means of four different combinations of optical and electrical attenuation, as shown in Table I. This system permits operation of the measuring phototube over an illumination range of only 100 to 1, and still provides an essentially electrical calibration.

If the operator accidentally subjects the phototube to excessive illumination, for example by switching to the higher-density ranges without first inserting a high-density sample, a shutter in the measuring beam automatically closes to prevent phototube drift.

The function of tracking adjustment 2 (potentiometer R1) is to compensate electrically for a reasonable manufacturing tolerance in the densities of the two-step filter. The high-density half is purposely made with an average transmittance, relative to the clear half, of somewhat more than 1%. When the range switch, S1, is in either of the two lower ranges, the full resistance of potentiometer R1 is connected in series with the 90-cycle

Table I

Range	Filter Step	Attenuator Gain	Relative Sensitivity
0 to 1	Dense	0.1	0.001
1 to 2	Dense	1	0.01
2 to 3	Clear	0.1	0.1
3 to 4	Clear	1	1

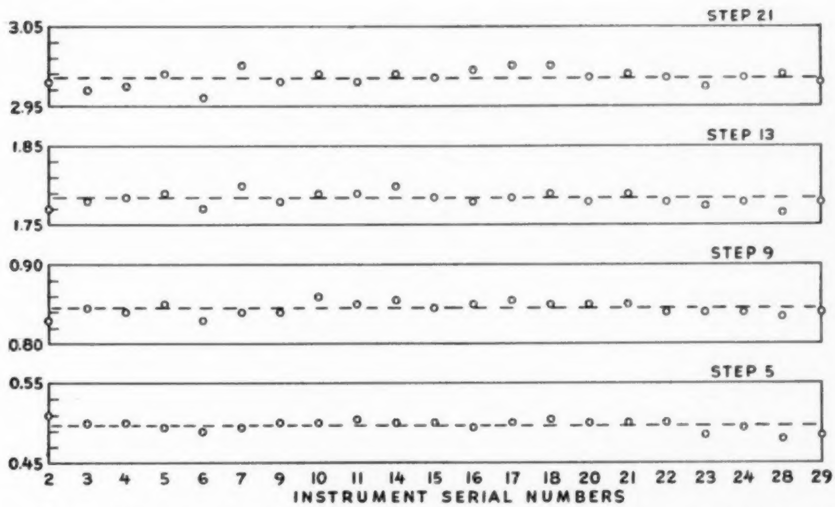

Fig. 8. Agreement among individual instruments, as shown by readings made on a Kodachrome Film step tablet with 21 Type 31A densitometers. The dashed lines are averages.

signal circuit. In the two higher ranges, the contacts of the range switch short-circuit an adjustable portion of the potentiometer. The resulting increase in gain can be adjusted to compensate exactly for the error of the two-step filter. The procedure for obtaining the proper setting is again simply one of making the densitometer "track," in this case between the second and third density ranges.

Performance

The performance of the densitometer can be evaluated in terms of measurements made with a number of Type 31A instruments in actual field service. Data of this kind are regularly collected by the Densitometer Control Center at Eastman Kodak Co., in the form of density readings taken with each instrument on a set of test samples. The samples are circulated among the laboratories and processing stations at which the densitometers are located, and the readings are collected and analyzed. Some data from a typical intercomparison (June–September, 1952) are plotted in Figs. 8 and 9. Included are a total of 21 Type 31A densitometers located in all parts of the United States and in Honolulu and Toronto. All are equipped with glass-gelatin color filters. The instruments have been in service for periods ranging from two to three years.

Figure 8 gives the readings of the 21 densitometers on four steps of a near-neutral Kodachrome Film step tablet, made through the green filter in each case. The average readings for the group are indicated by dashed lines. It is convenient to express the degree of consistency among instruments by the standard deviation, defined by the relation

$$\sigma = \sqrt{\frac{n\Sigma x_i^2 - (\Sigma x_i)^2}{n(n-1)}}$$

where σ is the standard deviation, n is the number of instruments, and the x_i are the readings of the individual instruments. For the steps of lowest and highest density, the standard deviations in the green are respectively 0.008 and

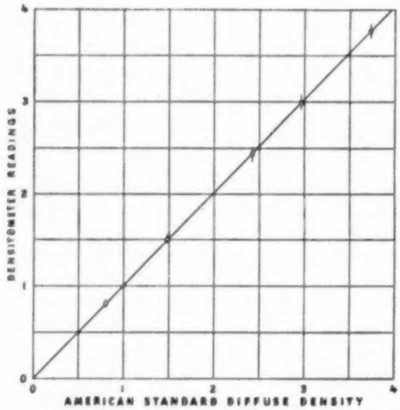

Fig. 9. Relationship of Type 31A densitometer readings on diffusing samples to American Standard diffuse density. Each circle is the average of the readings of 21 densitometers on a photographic silver patch. The vertical lines through the circles show the total spread among the instruments.

0.011 density unit. When the data for all three color filters are included, the average standard deviation for the four steps is 0.013 density unit, or less than 1% of the average measured density.

The absolute accuracy of the densitometer can be evaluated by comparison with a densitometer having one of the configurations described in the American Standard for diffuse transmission density. As a part of the intercomparison procedure, readings are taken on a series of near-neutral patches that have been calibrated with the standard opal-glass visual densitometer of the Physics Division of the Kodak Research Laboratories. Corrections are applied to the opal-glass readings as specified in the Standard. The readings with the Type 31A densitometers are made through filters that produce the spectral response required for measurement of visual density. Both low-diffusion (Wratten Filter No. 96) and high-diffusion (photographic silver emulsion) patches are used. With each of the patches, the average of the readings of the 21 densitometers agrees with American Standard diffuse density within 1.0%. The spread among individual instruments is greater with the diffusing silver patches than with the Wratten Filter No. 96 patches, possibly because of small variations in the cathode structures of different 1P42 phototubes. The readings on five silver patches are plotted against American Standard diffuse density in Fig. 9, which shows both the group average and the total spread between the highest and the lowest reading.

Acknowledgments

The author wishes to acknowledge the cooperation, in this development, of the following Kodak groups: the Service Group and the Committees of the Densitometer Control Center, who specified the requirements, aided in the design, and prepared the instruments for service; and the members of the Precision Instrument Engineering Department and the Electrical Laboratory, Hawk-Eye Works, who were responsible for the engineering, construction and preliminary testing.

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Motion-Picture Sound Installation at the University of California at Los Angeles

By BARRY EDDY

The pedagogic needs for 16mm sound motion-picture production are discussed with a statement of the problem and a demonstration of its solution. The requirements include facilities for production recording, dialogue replacement, scoring and re-recording. All recording is done on 16mm magnetic film. The magnetic composite track is transferred to 16mm photographic negative for release. Equipments are being installed to permit variable-density, ultrasonic electric printing to Kodachrome and black-and-white. The simplicity and dependability of the magnetic equipments permit of student operation.

It is patently impossible to teach the art and craft of the motion picture unless the actual experience of making a film can be provided. To make a motion picture one must have adequate equipment. It is to this end that the Theater Arts Department of the University of California at Los Angeles has established a complete Motion Picture Division. Here the student has the opportunity to study at firsthand the various techniques and practices, crafts and arts, that constitute the modern film. Not the least of these is the recording and handling of the sound track through all its phases, from production recording, scoring, dialogue replacement to re-recording and the making of the release negative. To make this phase possible the Regents of the University of California provided the Motion Picture Division with a complete sound department. It is the purpose of this paper to describe this installation.

It was decided at the outset to use magnetic film and take advantage of the saving in cost and the improvement in fidelity, the latter being particularly desirable, inasmuch as all production is done on 16mm film. The use of higher speeds to increase the frequency range was deemed completely unnecessary since the frequency range at 36 fpm exceeds the playback characteristics of even the most expensive 16mm projectors. And it is apparent that maximum simplicity in film handling obtains when the sound track can be run on standard equipment, obviating the need for

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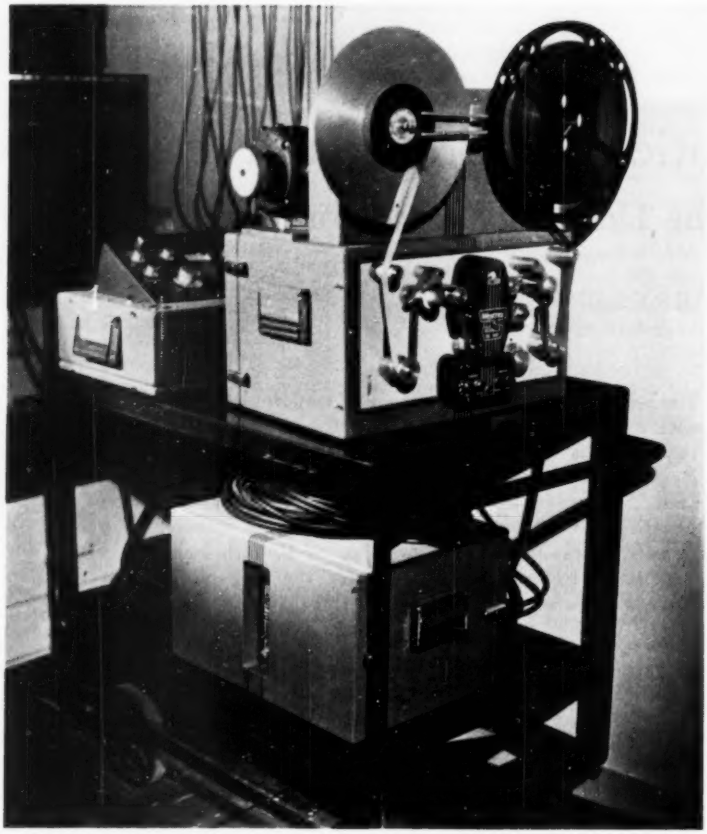

Fig. 1. Portable magnetic recording channel mounted on heavy-duty steel truck.

specially geared synchronizers and Moviolas.

Those recordings which do not require synchronization or precise timing are done on quarter-inch tape. The tape recorder has proven ideal for obtaining location sound effects where its light weight and low operating noise are needed. The acquisition of synchronous tape equipment was deemed financially extravagant since the cost of the machine is quite high and the bulkiness and complexity of the associated control equipment mitigate against ease of operation and maintenance by untrained students. The investment in magnetic film held as dialogue protection during a production would never equal the cost of synchronous tape equipment or compensate for the complexity of operation. And, of course, there is no problem of print-through with magnetic film.

From the Westrex Corp. was obtained a portable 16mm magnetic recording channel[1] that is used for both stage and location production work, as a scoring channel where no more than two inputs are required, and as an interlocked machine for composite re-recording. This equipment, shown in Fig. 1, con-

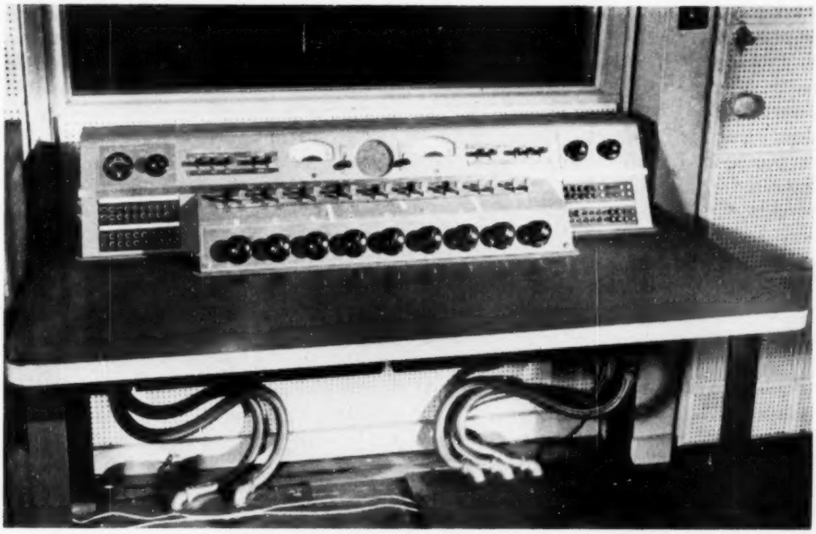

Fig. 2. Western Electric 25B console showing removable wall section and window.

sists of the RA-1467 recorder, RA-1484 control unit and the RA-1485 mixer. The equipments are mounted on a heavy-duty steel truck. The mixer unit is stored on the truck when not in use. Remote-control circuits permit starting and stopping of the recorder from the mixer unit, plus a signal light that indicates that the machine is up to speed and stabilized. Only two operators are required, one on the mixer and one on the boom. It is our practice to place the equipment in the hands of the students as part of their training. The ruggedness and simplicity of the equipment, along with the ease of operation and wide tolerance limits for satisfactory recording, make this practice entirely feasible and desirable.

Mounted on top of the recorder and visible in Fig. 1 is the interlock motor, coupled to the internal driveshaft by means of a rubber timing belt. The addition of this motor has in no way affected the low flutter-content of the recorder. The recorder has within it a 110-v synchronous motor which is used whenever the interlock motor is not required.

The sound equipment is housed in two rooms at one end of the production sound stage. One room contains the portable recorder, film playbacks, interlock patch board, projector and the photographic recorder. The mixer console and monitor horn are contained in the other room, separated from the sound stage by a double-glazed window. A part of the wall containing this window can be removed during re-recording to permit the sound engineer to listen to the screen horn rather than the one in the mixing room.

The mixer console, shown in Fig. 2, is a modified Western Electric 25B broadcast console, which at first glance might appear ill-suited to motion-picture work, but which has proven to be quite easily modified for dubbing, scoring and re-recording for the small studio. The modification consists almost entirely in rewiring the patch board on the left-hand side of the console to make all of the attenuator inputs available on the jacks.

This provides seven inputs operating at approximately −20 db, with four of the attenuators also capable of being fed from microphone preamplifiers contained within the console itself. Additional gain for low-level dialogue pickup is provided by an external amplifier mounted in a separate cabinet with the equalizers. The latter consist of a two-way unit operating at 100 and 8000 cycles and a five-way unit operating at 100, 400, 1000, 3000 and 6000 cycles. Separate amplifiers compensate for the insertion loss of the equalizers. Plug-in low-pass filters effective in the monitor circuits are provided to simulate average 16mm playback conditions.

Standard circuitry of the Western Electric 25B console provides two separate and independent channels, either of which may feed one or two recorders at the same time. Each channel is provided with its own volume indicator. The monitor amplifier is switched between these two channels as desired. Having two separate channels makes it possible to use one for recording and the other for playback through headphones for cueing purposes, for example, and yet not intermix the two signals. Keys originally intended for inter-studio signalling, provide remote control of the sound stage warning lights and the interlock-motor starting circuits.

The interlock system is interesting in that no distributor is needed. Each motor, a Westrex RA-1409, contains within the same frame, a 220-v, 3-phase synchronous section and a 220-v, 3-phase selsyn section, both rotors, of course, being mounted on the same shaft. For interlock operation it is merely necessary to couple the selsyn rotors of the several motors together, then apply 220-v, 3-phase power to the stators of the synchronous and selsyn sections of the several motors. Starting resistors and cutout relays in the synchronous section circuits provide for a slower and smoother starting characteristic.

To provide for two independent interlock operations to be carried out at the same time, an interlock patch board was designed and built by Westrex and is shown in Fig. 3. This board is capable of controlling eight motors together or two groups of four independently.

The special 16mm projector consists of an Ampro Stylist mounted on a ventilated motor box, as seen in Fig. 4. This box contains the interlock motor described above which is coupled to the projector shutter shaft by a length of silent chain; a selsyn generator for the remote footage counter; and the necessary starting and lamp-control relays. The motor within the projector is used only to drive the lamp cooling fan. The projector lamp and cooling motor are turned on when the third phase of the synchronous/interlock motor is energized. Between the projector and the double-glazed window is mounted the loop rack used in dialogue replacement.

Turning next to the reproducing equipment, we see in Fig. 5 an array of three cabinets. The one on the left contains two Stancil-Hoffman S-5 film playbacks. The center cabinet is a Westrex RA-1502-A re-recorder capable not only of playing photographic or magnetic tracks, but also of recording on magnetic film. On the right of this machine is a Westrex RA-1495-B photographic/magnetic playback or re-recorder as it is called. With the equipment described it is possible to re-record from four interlocked tracks at the same time. A pair of turntables and a tape recorder/playback are available for nonsynchronous effects and music.

A Westrex 300 Type photographic channel[2] is used for making density release negatives from the magnetic composite re-recordings and at the present time is being modified to permit ultrasonic, direct-positive electric-printing to black-and-white[3] or color[4] for answer and high-quality release prints.

All recording with the exception of release negatives or electric prints is done on 16mm single-perforated magnetic

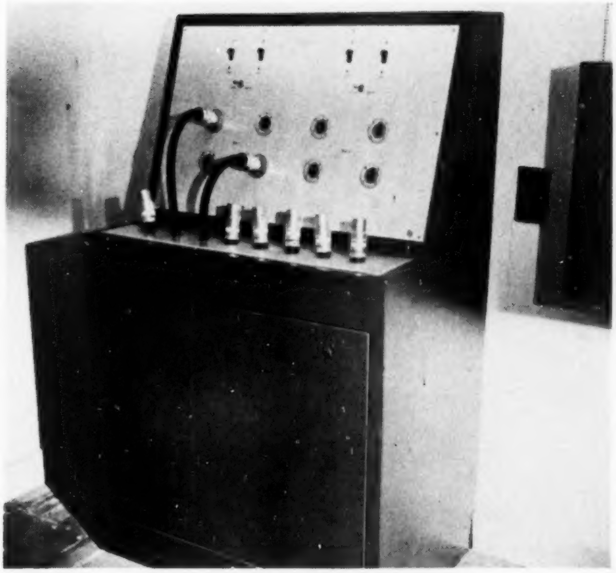

Fig. 3. Westrex interlock patch board.

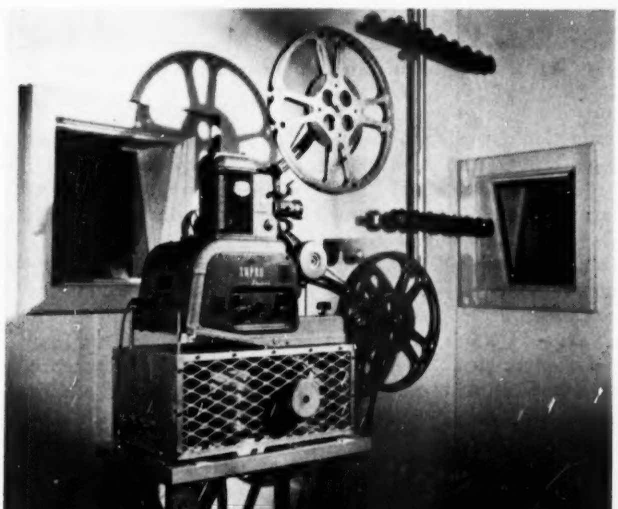

Fig. 4. Ampro Stylist projector with interlock motor and loop rack.

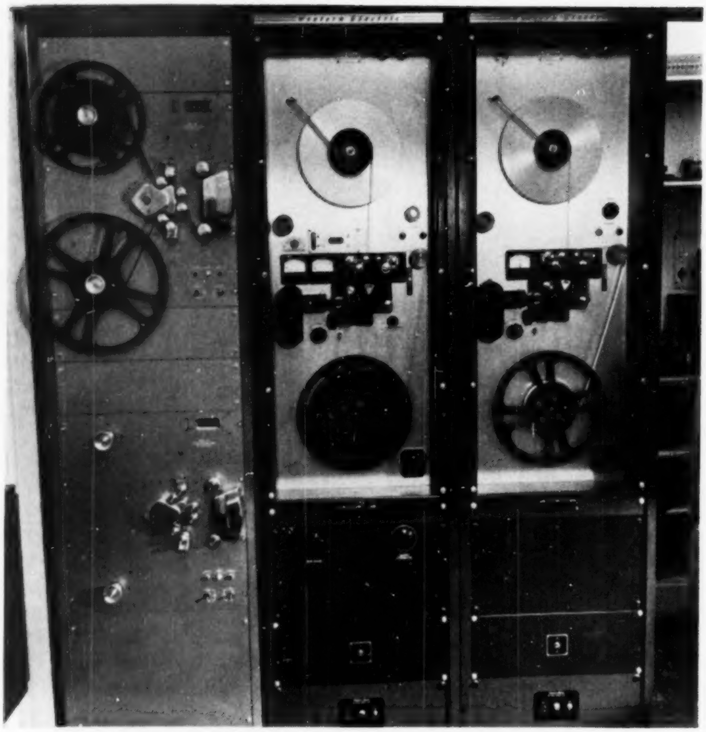

Fig. 5. Stancil-Hoffman and Westrex film playbacks.

film. In production recording, dialogue is recorded on 1200-ft rolls which are stored until the picture is finished. The print-takes are transferred from the production rolls, two exact copies being made, one on new stock, the other on old, spliced stock. After these two copies have been given identical edge numbers, the one made on old stock is used as the work track during editing. The copy made on new stock is matched to the work track by means of the edge numbers and used in the re-recording.

With the advent of magnetic sound recording film in the making of motion pictures, the teaching process has been greatly simplified, but it is not so obvious that the process has been enlarged through the means of immediate playback. The result of a class exercise or student experiment can be studied immediately and repeatedly with no time lost for processing or printing and at an absurdly low cost.

The purpose in choosing professional sound recording equipment was multifold. Chief among its virtues are its dependability, freedom from breakdown and frequent maintenance, wide frequency-range with a minimum of noise, distortion and flutter, and such simplicity that students unfamiliar with sound recording techniques can learn to operate the equipment well and safely without constant and close supervision. It also serves the not unimportant function of familiarizing the students with professional equipment and training them to

appreciate the high quality of sound recording obtainable with present-day professional standards and practices. By providing the student with competent equipment, the only limitation to his learning experience resides within himself.

The author wishes to take this opportunity to express his appreciation to the engineering staff of the Westrex Corp. for their kindness and cooperation in this project and in particular to Allan McLean, whose help and advice were invaluable.

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Improved Equipment for Drive-in Theaters

By R. H. HEACOCK

Present trends in drive-in theaters, particularly as applied to light sources, projectors, sound systems, power supply units and projection lenses, are contrasted with those of several years ago. Current drive-ins favor the use of 9-mm and 10-mm positive carbons in reflector-type arc lamps in combination with the new 4-in. diameter lens. Comments are offered on the impact of three-dimensional pictures on drive-ins.

The purpose of this paper is to indicate briefly present trends in drive-in theater construction and operation as compared with conventional practice in this field in the first two or three years immediately following World War II.

Arc Lamps

Immediately after the war many smaller drive-ins were constructed making use of the conventional 70-amp "Suprex" type lamp. Seven- or 8-mm carbon trim was conventional, and in an attempt to get more light on the screen operating amperages were gradually pushed higher and higher. Lamps that were originally designed for operation at a maximum of 70 amp were pushed up to possibly 75 amp, and the increased amount of heat generated within the lamp frequently resulted in door handles and operating controls being extremely hot.

It was at this time that the condenser lens type of lamp began to increase in popularity. As drive-in screens became larger, booths were operated with the 150-amp 13.6-mm positive carbon, and soon after this the use of the 170-amp 13.6-mm positive carbon was popular. When the 180-amp "Hitex" carbon was introduced, it was broadly used in the largest drive-in theaters in the country. The use of these higher amperages above 150 amp made it necessary to use some means of cooling the film in the projector aperture. Certain lamps made use of heat-absorbing glass which would remove approximately 40% of the heat, but unfortunately absorbed about 20% of the light. Another bad feature of these heat-absorbing glasses was the fact that they changed the color of the spectrally white light, giving it a slightly bluish-green color which was quite noticeable. A practical test was to raise gradually the heat-absorbing glass from the light beam, and this could be immediately noticed on the screen due to the fact that not only the screen brilliance markedly increased but also the color of the light was a more spectrally balanced white light. With this type of heat-absorbing glass, it was frequently found that a drive-in theater could actually get more light on its screen with the use of 150-amp carbon operating at 150 amp, than was possible with the use of the 170-amp carbon operating at 170 amp with the heat-absorbing glass in the light beam.

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Within the last couple of years, heat-reflecting glasses have been employed which reflect a high percentage of the heat, and yet cut down in light transmission only about 8%. Difference in color and apparent brilliance of the screen are, for practical purposes, the same whether this heat-reflecting glass is in the light beam or not. At first, difficulty was experienced in disintegration of the multilayer microscopic coatings on the glass. Currently a small motor-driven blower directs cool air on a slightly inclined heat-reflecting glass so that it carries heat away from the surface of the glass. The glass is inclined slightly so that the heat reflected is directed to the top of the arc lamp. When used in combination with this small blower, satisfactory results have been obtained.

A completely different approach to the problem of heat on the film in the projector aperture was introduced with the use of an air compressor, which directed compressed air under approximately $4\frac{1}{2}$-psi pressure on each side of the film in the aperture. This cool air would carry away heat from the film in the aperture and, of course, did not absorb any of the light. This type of lamp, therefore, made it possible to get approximately 20% more light on the drive-in theater screen than was the case when the heat-absorbing glass of that day was used. The air-cooled projector in combination with the condenser-type lamp operating at 180 amp, therefore, became very popular in the largest drive-in theaters in the country.

Simultaneously with the increase in the use of condenser-type lamps, it became the vogue to equip 70-amp Suprex-type arc lamps with various types of water coolers, which made it possible to operate these lamps up to possibly 82 to 85 amp.

This procedure was actually a makeshift, and although it temporarily increased the light on drive-in theater screens a great deal of maintenance difficulty was experienced through leaking water jackets, difficulty in carbon alignment and operating troubles that generally crop up when a lamp designed for operation under certain conditions is converted in the field to operate under markedly differing conditions. This introduction of water-cooled positive guides in the field resulted in giving a "black eye" to this type of equipment.

During the past several years, reflector-type arc lamps have been introduced which have been carefully designed from the beginning for operation with 9- or 10-mm positive carbons. These lamps have adequate internal volume to give sufficient cooling. Their reflectors are large (16 in. in diameter as compared to the $13\frac{1}{2}$ or 14-in. diameter of the Suprex-type lamps). Some of these lamps are factory-equipped with water coolers which are a far cry from some of the earlier improvised units originally employed. Current water coolers are manufactured from solid brass stock so that there is no possibility of leakage through loose or faulty joints. Contact with the positive carbon is through silver jaws, which have adequate area to reduce both heat and corrosion. When the 9- and 10-mm reflector-type arc lamps were first introduced, it was customary to use them at the maximum amperage recommended for this type of carbon. Ten-millimeter lamps were operated at a full 100 amp even though carbon consumption was excessive; the 9-mm carbon was operated at a full 90 amp. We have gradually learned the hard way, through actual field operation, that it is advisable to use the current 10-mm trim at approximately 95 amp, and the 9-mm trim at about 86 amp. This results in very steady, uniform light with trouble-free operation and economical carbon consumption.

Water Circulators

In the last couple of years water circulators have been introduced for drive-in theater use which have been very helpful

in eliminating uncertainties of water supply. In certain areas disastrous results have followed a breakdown in the water supply if this came from a local well or from some other makeshift arrangement. In other localities foreign substances in the water might seriously clog and impair free water flow. Water circulators use over and over again a relatively small supply of water, which is cooled by means of a fan and a cooling coil with each circulation through the system. These units are relatively inexpensive (one very good unit has a full list price of just under $100.00).

Power-Supply Units

Motor generators are still the backbone of the power-supply units for drive-in theaters. This is primarily because relatively high amperages are required. Of course, motor generators have had to be carefully matched to the arc lamps so that very soon after the war one of the most popular motor generators was an 80/160-amp 60-v unit. When the condenser-type lamp was used, larger motor generators were necessary, and we finally worked up to a 250/360-amp 100-v unit for use with the "Hitex" positive carbon at 180 amp. More recently, the reflector-type lamps have reduced the motor generator size so that now a very popular unit is a 100/200-amp 75-v motor generator.

Tube-type rectifiers are quite popular in the smaller drive-ins, and although maintenance costs are relatively high due to rectifier tube replacement, the initial cost is quite low, and this accounts for their wide popularity in the smaller drive-in theaters. More recently, the selenium-plate type of rectifiers has been introduced, and these are very popular up to 100-amp supply.

Projectors

Since drive-in theaters are frequently very dusty, it has been recognized from their inception that projectors which make use of automatic lubrication are essential for low maintenance costs (Fig. 1). This type of projector has all of its mechanical drive carefully sealed so that dust cannot get in and the lubricating oil cannot get out. Not only is automatic lubrication excellent from a lubricating viewpoint, but it also acts as a cooling system so that any points that might become locally hot due to extremely close tolerances, have this heat carried away and distributed over the complete projector main case housing.

Due to the fact that it is essential to get as much light through to the screen as possible, a projector should be employed which passes 50%, or more, light through to the screen. In general, a double-shutter projector passes approximately 20% more light than does the same projector when employed with a single shutter.

Sound Systems

Recent improvements have been made in sound systems such that they are truly building-block systems. Various amplifying units may be made use of so that systems can be built up to give out necessary wattage for ample coverage of any drive-in theater.

The drive-in theater speaker (Fig. 2) has become more and more standardized so that a very light but strong housing is employed around a relatively small but carefully designed loudspeaker unit. This unit has been designed to withstand most severe usage and yet produce high-quality sound.

Projection Lenses

Several years ago the 4-in. diameter projection lens was introduced which has a speed of either $f/1.9$ or $f/2.0$. These lenses are produced in focal lengths above 5 in. Before the introduction of the 4-in. diameter projection lens, it was necessary to have the projection booth relatively close to the screen due to the fact that if a focal length lens above 5 in. was employed, it was so slow that it could not pass enough light to the screen.

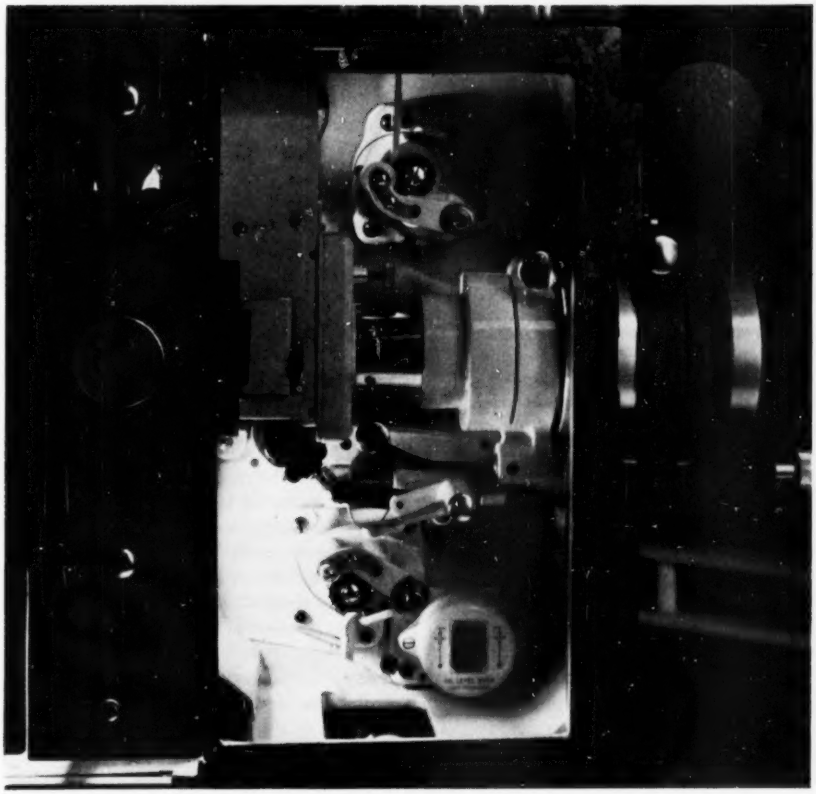


Fig. 1. The RCA-100 Projector.

This meant that in order to have both the booth and the concession stand in one structure the concession stand was fairly close to the screen. This meant that most of the patrons who, of course, were grouped near the back of the drive-in theater, since the ramps there are very much longer, had a long distance to go to reach the concession stand. Another objection to the location of the booth close to the screen was that it interfered seriously with traffic, and frequently many people avoided the area behind the booth even though these would normally be the choice positions since they are close to the center line of the theater.

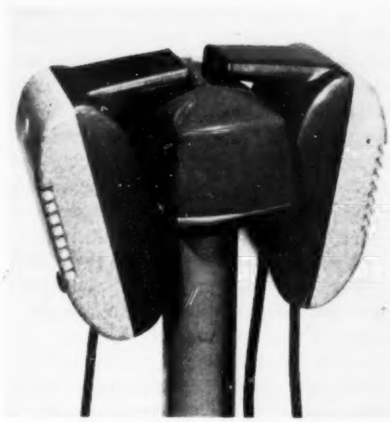


Fig. 2. The RCA Drive-In Speaker Station.

The 4-in. diameter projection lens has changed this situation by making it possible to have both the booth and concession stand well back in the theater so that both of the objections outlined above have been overcome.

Impact of Three-Dimensional Pictures on Drive-in Theaters

When *Bwana Devil* was introduced this year, its extreme popularity resulted in great interest in whether or not the conventional type of polarized-light three-dimensional pictures might be presented in drive-in theaters. Since the light level in most drive-in theaters leaves much to be desired, it is immediately obvious that the use of polarized-light port filters and audience spectacles will introduce a very serious problem. The combination of these two filters (one in the booth port and one in front of the viewer's eye) will pass only approximately one-third of the light from the projection lens through to the viewer's eye.

Even so, certain venturesome exhibitors have painted their drive-in theater screens with varying success. Since it is essential to have a metallized or silver screen surface, some drive-ins merely sprayed their present screens with a mixture of one pound of chemically pure aluminum powder cut in one gallon of clear spar varnish. This resulted in a highly directional screen such that the center one-third of the viewing area was at a markedly increased apparent screen brilliance level. The next one-sixth of the viewing area on each side was at approximately the same level as the original white diffusive screen, while the remaining one-third of the viewing area was very much lower in apparent screen brilliance than with a white diffusive screen.

Various materials have been used in combination with the aluminum powder combination in an attempt to get a slightly more diffusive screen without depolarizing the light. These attempts have met with varying degrees of success.

One thing of interest to us, as engineers, is the experience of certain drive-in operators which closely parallels that of some of our laboratory experiments in that it was at first thought that the answer had been obtained quite simply. Some exhibitors merely sprayed their screens with the aluminum powder spar varnish combination, and were delighted to find that they obtained excellent results with three-dimensional pictures. Light was not depolarized, the picture was clear and the screen appeared surprisingly uniform, as far as screen brilliance was concerned. Unhappily, however, these exhibitors found that when they returned to two-dimensional projection, the increased light striking on the screen made very much more apparent what had been minor differences in reflectance under the very low levels of three-dimensional projection. They therefore found that unfortunately they had a relatively satisfactory screen for three-dimensional projection, but one that was noticeably deficient for the projection of standard two-dimensional pictures at their higher light level. It is certain that many of us, as engineers, have experienced similar disappointments when we have felt that we have at last obtained an answer to our problems, only to find that, through our own efforts, varying conditions of operation do not make our achievement as worthwhile as we had at first anticipated.

At this very moment there may be drive-in theaters that are operating satisfactorily with either two-dimensional or three-dimensional pictures projected on the same screen. If this is the case, we have not been in those particular drive-ins. All can probably agree, however, that it is only a question of time until some satisfactory balance between diffusive and depolarizing properties of materials has been made to give a reasonably satisfactory screen for the projection of both types of pictures in drive-ins.

Drive-in Theater Dub'l Cone In-a-Car Speaker

By J. ROBERT HOFF

A new, improved in-a-car speaker in which the speaker unit employs two speaker cones, one superimposed upon the other with a sealed $\frac{3}{16}$-in. air space between, the outer cone being used for protection, the inner cone for projection of sound.

ALTHOUGH the first drive-in theater was in operation in the middle 30's and in-a-car speakers were in use prior to World War II, it was not until the great increase of new drive-in theaters after the war that the modern in-a-car speaker made its appearance. Since that time almost all major manufacturers of sound and projection equipment have employed a speaker unit with a paper cone somewhere between 3 in. and $5\frac{1}{2}$ in. in diameter, with the majority using a 4-in. cone.

The size of an in-a-car speaker cone has been dictated by two definite restrictive facts. First, any speaker in an enclosure must have air space, or breathing space, so as not to overload the speaker and smother the sound. Second, the speaker outer case, whether die or sand-cast aluminum, or die-cast plastic or other material, had to be small enough so as to be easily handled and transported from the speaker post to the car interior. It was determined by most major manufacturers that the 4-in. diameter speaker unit was the best size to provide adequate loading and yet not require a case that was large and cumbersome.

One of the first objections raised in connection with the enclosure of a standard speaker cone was that, because the first speaker units used were merely adapted from indoor applications, the paper cones quickly deteriorated in rain and damp weather and became useless until reconed. The several manufacturers of these inner cones then proceeded to use a waterproofing material to protect the cones from the weather and make them water resistant. While this prolonged the life of the speaker units it was found that the sun shining through the speaker case openings baked out the waterproofing material and made them again pervious to moisture. When louvres were extended over the openings to prevent the sun's rays from reaching the cone the sound became muffled and the speaker's efficiency lowered. Thus the problem presented itself of providing some protection for the cone without such protection resulting in a deleterious effect on the sound reproduction.

Many methods were investigated including the use of a linen or rubber cover, and making the cone itself of

Presented on April 29, 1953, at the Society's Convention at Los Angeles by J. Robert Hoff, The Ballantyne Co., 1712 Jackson St., Omaha 2, Neb.
(This paper was received on February 17, 1953.)

Fig. 1. Field Mount Dub'l Cone In-a-Car Speaker.

plastic, spun aluminum and rubber fabricated paper. But all of these proved ineffective because they affected the sound quality. It was then decided to superimpose a second cone in front of the first and it is upon this theory that this paper is presented. The Dub'l Cone In-a-Car Speaker unit is practical for the following reasons:

1. It protects the inner cone from both the sun and the rain.

2. The addition of the second cone plus a larger permanent magnet than is required for a single cone gives a very pleasing response.

3. When the outer cone becomes sun-baked and deteriorated it can be replaced in the field with a new cone and gasket and the life of the inner cone and the speaker unit itself prolonged indefinitely.

The Dub'l Cone Speaker unit (Fig. 1) has an aluminum voice coil, a resin-impregnated diaphragm, and both cones are treated with water repellent. Waterproof cork gaskets provide a resilient seal between both speaker cones and between the inner speaker cone and the housing. The housing itself is an all-weld construction which gives rigidity to the entire speaker under all kinds of temperature variations. Ordinarily single-

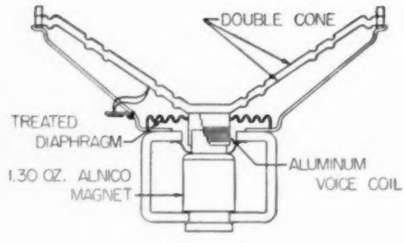


Figure 2.

cone speakers employ a 0.68-oz magnet. Because of the added load of the second cone the magnet in the Dub'l Cone Speaker is 1.3 oz and the magnet material used is selected Alnico V which is two and one-half times more powerful than previous magnetic materials. Thus every point in an in-a-car speaker unit that can be attacked by hot sun or rain has been protected (Fig. 2).

A coincidental result of the second or outer cone was the action it takes at the extreme high end of the response curve. It brings about a much sharper cutoff. In addition the mass-loading through the second cone causes a shifting of the resonance point with a slight additional response in the 500- to 1000-cycle range.

A comparison of the frequency response of a single-cone speaker with that of a Dub'l Cone Speaker is shown in Fig. 3. The solid line is the response of the Dub'l Cone Speaker and the dotted line, response of the same speaker with the outer cone removed. This graphically demonstrates that the Dub'l Cone has greater response between 100 and 200 cycles with a definite cutoff at 4000 cycles. The single-cone speaker while reaching 5000 cycles definitely does not have as sharp a cutoff. The Dub'l Cone Speaker thus eliminates the undesirable high-frequency noises which may be present on the sound track, giving a cleaner reproduction than would otherwise be possible.

The Dub'l Cone Speaker unit is mounted in a die-cast aluminum case. The front half of the case is provided

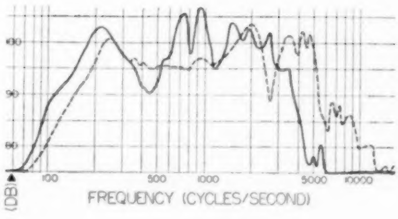


Figure 3.

with a flange into which the outer cone and ring fit. In addition there are aluminum protrusions that fit into the holes in the frame to position the speaker. The Dub'l Cone Speaker is held in position by a spring which is placed at the magnet end of the speaker unit and fits into a recession in the back half of the speaker. The advantage of this floating torsional mount is that the speaker-unit frame is protected against warping which would cause the voice coil to drag. Sound pressure curves show that the spring has no effect on the response. The housing has been designed to be so sturdy that no 4-in. speaker will deliver sufficient power to cause distortion by vibrating the curved back of the case.

Inasmuch as the inner speaker is protected by the second cone, the opening in the front of the speaker case is wide to provide a smooth passage of sound and eliminate muffling. A special drain is provided at the bottom of the flange in the speaker case so that water will run freely in front of the volume control and out of the case.

When the outer cone deteriorates it is easily removed without damaging the inner cone. The manufacturer supplies replacement cones and cork gaskets, together with cement and instructions in a kit. Cement is applied to the outer rim of the inner cone, the new cone put in place and then the gasket cemented to the outer cone.

Sound Committee Report

By JOHN K. HILLIARD, Chairman

THE WORK OF the Sound Committee must of necessity include investigation on all phases of techniques used in stereophonic sound reproduction. It was indeed fortunate that last year the Magnetic Subcommittee was able to obtain agreement on the triple 200-mil magnetic track for 35mm film since this is the standard that is being used currently on 3-D showings where the sound is reproduced from a separate interlocked magnetic dummy.

The projects of the committee at the present time include:

1. Preparing a magnetic azimuth test film.
2. Magnetic multitrack frequency film.
3. Magnetic 3000-cycle flutter film.
4. Triple-track dialogue and music test reel which will have identical material on all three tracks. This, when combined with a horn-switching unit, will enable the installation crew to determine that the horn system has been installed properly and that the distribution pattern is adequate. The procedure will be to switch back and forth from one channel to the other so that any change in quality may be noted.
5. The standard theater sound reproduction curve.

At the present time agreement has been reached on the amount and nature of the low-frequency equalization. There are differences of approximately 4 db in the recording characteristic at 8000 cycles between two major producers of apparatus for 35mm magnetic recording and it is hoped that very shortly agreement can be reached so that one theater reproducing curve will be suitable for all productions. At the present time there is no intention of limiting the frequency range to 10,000 cycles.

Multimagnetic tracks for use on the regular 35mm release print were discussed briefly, but no concrete proposal has as yet been submitted for committee consideration.

The special Subcommittee on Magnetic Reproducing Characteristics, under the chairmanship of Ellis W. D'Arcy, discussed the 16mm reproducing characteristic which it had been assigned to formulate. It is realized that this matter will have to be resolved rapidly in order for the 16mm magnetic program to proceed on an orderly basis. A fine spirit of cooperation is being exhibited by the various equipment manufacturers and it is reasonable to expect that such a characteristic will be agreed on within the next sixty days. It will then be distributed to the full Sound Committee and at the same time will be published in the *Journal* for comments. The characteristic being considered at present is similar to that now used for 35mm magnetic track. It is hoped that the 16mm reproducing characteristic will approach the 35mm insofar as possible. This will expedite the rerecording process of 16mm magnetic sound track prints.

Presented on May 1, 1953, at the Society's Convention at Los Angeles by John K. Hilliard, Altec Lansing Corp., 9356 Santa Monica Blvd., Beverly Hills, Calif.

At the meeting of the Subcommittee a French proposed standard for magnetic track location was considered. It was agreed that the French proposal with respect to so-called "magnetic half-track" should be circulated with the hope of arriving at a standard location for such striping. Related problems include the design of a magnetic reproduce head which takes into consideration the question of magnetic head wear and photographic sound track damage, outlined at the Society's 1952 Washington Convention.

16mm and 8mm Committee Report

By MALCOLM G. TOWNSLEY, Chairman

SINCE ITS LAST REPORT, the 16mm and 8mm Motion Pictures Committee has processed in one manner or another, eight standards. Of these, one has just been approved as an American Standard, two are in the Standards Committee, having been approved by the 16mm and 8mm Motion Pictures Committee, one has been published for trial and comment, and four are still in letter ballot in the Committee.

All of the standards which are concerned with the usage of 16mm or 8mm film in camera or projector have been reviewed by the Committee and are currently in various stages of balloting as just indicated. I should like to express the deep appreciation of the Committee for the splendid work of D. F. Lyman of Eastman Kodak Company in re-drafting these standards into a consistent pattern and correct form and to thank Henry Kogel for suggesting a method of revising and simplifying titles. These standards now carry more descriptive material and explanatory notes than has been customary, and the Committee will welcome comments on this feature of the current revisions when they are finally released.

Several of these standards encounter the question of edge guiding of 16mm sound film. This has been a very thorny problem. Compelling arguments can be advanced for guiding at the perforated edge, and equally cogent reasons for guiding at the sound-track edge.

These two sets of reasoning are summarized in appendixes to the proposed standards, and really result in no standard at all being set for edge guiding. It is, however, beginning to appear that projector manufacturers are tending toward the solution of guiding the film at the picture gate from the perforated edge and at the sound scanning point from the unperforated edge, so that agreement on a standard may be possible in another year or two.

The Committee has requests for consideration of standards on the following:

Low-visibility splices;

Large 16mm reels (above 2,000 ft);

600-ft projector reels;

8mm reels; and

Travel-ghost film.

Comments and information on these subjects are invited.

Presented on April 30, 1953, at the Society's Convention at Los Angeles by Malcolm G. Townsley, Bell & Howell Co., 7100 McCormick Rd., Chicago 45, Ill.

Proposed Revisions, PH22.17, —.36 and —.58 Related to 8mm and 35mm Low-Shrink Film and Aperture for 35mm Sound Motion-Picture Projectors

Three proposed revised American Standards are published on the following pages for three-month trial and criticism. All comments should be sent to Henry Kogel, SMPTE Staff Engineer, prior to October 1, 1953. If no adverse comments are received, the three proposals will then be submitted to ASA Sectional Committee PH22 for further processing as American Standards.

The basic change in PH22.17 is one which makes allowance for the further decrease of the shrinkage characteristics of safety film. This question arose first in the review of the two standards on 16mm Film Dimensions, PH22.5 and PH22.12. The revisions made in those standards, and reasons therefor, are virtually the same as for the present revision of this 8mm standard. Refer to Dr. Carver's statement, in the December 1952 *Journal*, p. 527, for the Committee's detailed thinking on this subject.

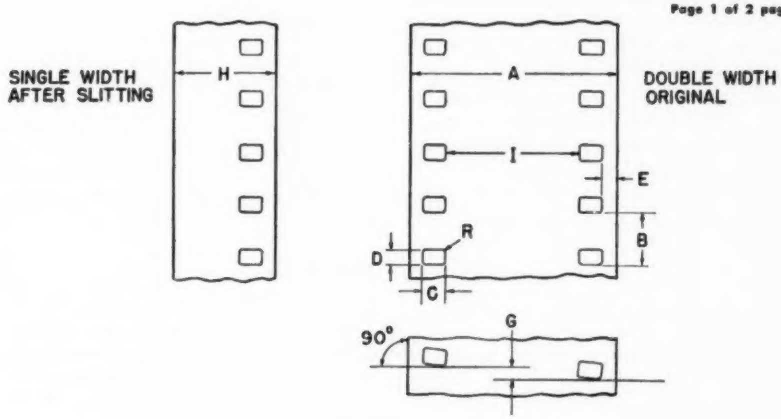
On PH22.36, only a minor revision is involved, affecting the method of indicating dimension G. This new method provides for the measure of both the linear and angular misalignment of any pair of perforations and brings this proposal in accord with international practice.

In reviewing PH22.58, the Film Projection Practice Committee came to the conclusion that the camera centerline should be deleted as well as dimension H which specified the 6-mil differential between camera and projector centerlines. The 6-mil differential was originally inserted to make allowance for film shrinkage so that the release print, after shrinking its normal amount, would have the image centered in the projector aperture. The decrease in the shrinkage characteristic of film eliminates the need for this differential, and now permits the use of the projector aperture centerline for both the projector and camera. In addition, the corner radius has been decreased to be in accord with present practice of essentially square corners.—*H.K.*

Proposed American Standard

Dimensions for 8mm Motion-Picture Film

PH22.17
Revision of Z22.17–1947



Dimensions	Inches	Millimeters
*A	0.629 ± 0.001	15.98 ± 0.03
†B	0.150 ± 0.0005	3.810 ± 0.013
C	0.072 ± 0.0004	1.83 ± 0.01
D	0.050 ± 0.0004	1.27 ± 0.01
*E	0.036 ± 0.002	0.91 ± 0.05
G	Not > 0.001	Not > 0.025
H	0.314 ± 0.002	7.98 ± 0.04
I	0.413 ± 0.001	10.490 ± 0.025
‡L	15.000 ± 0.015	381.00 ± 0.38
R	0.010	0.25

These dimensions and tolerances apply to negative and positive raw stock immediately after cutting and perforating.

* For low shrink film as defined in Appendix 2, A shall be 0.628 ± 0.001 and E shall be 0.0355 ± 0.0020.

† In any group of four consecutive perforations, the maximum difference of pitch shall not exceed 0.001 inch and should be as much smaller as possible.

‡ This dimension represents the length of any 100 consecutive perforation intervals.

NOT APPROVED

Appendix 1. Uniformity of Perforations

The dimensions given in this standard represent the practice of film manufacturers in that the dimensions and tolerances are for film immediately after perforation. The punches and dies themselves are made to tolerances considerably smaller than those given, but owing to the fact that film is a plastic material, the dimensions of the slit and perforated film never agree exactly with the dimensions of the punches and dies. Shrinkage of the film, due to change in moisture content or loss of residual solvents, invariably results in a change in these dimensions during the life of the film. This change is generally uniform throughout the roll.

The uniformity of perforation is one of the most important of the variables affecting steadiness of projection.

Variations in pitch from roll to roll are of little significance compared to variations from one sprocket hole to the next. Actually, it is the maximum variation from one sprocket hole to the next within any small group that is important. This is one of the reasons for the method of specifying uniformity in dimension B.

Appendix 2. Shrinkage Characteristics

In the early days of 16mm film the safety base used for this film had the characteristic of shrinking very rapidly to a certain fairly definite amount and then not shrinking much more. Although this film tended to swell at high humidities, nevertheless the shrinkage that occurred in the package before the user received the film was always at least as great as any swell that might occur due to high humidities at the time of use. This meant that the user never encountered film, even at high humidities, that had greater width than that specified in the standards. This meant that camera and projector manufacturers seldom ran into trouble so long as their film gates would readily pass film at the upper limit of the slitting tolerances, namely 0.630 inch.

Within the past few years, however, a safety base with lower shrinkage characteristics began to be used. Although this film was less susceptible than the previous film to swelling at high humidities, nevertheless the shrinkage characteristics were low enough so that this shrinkage did not always compensate for the swell at high humidities. For this reason film slit at the mid point of the tolerance for width, namely 0.629 inch, would occasionally swell at high humidities to such an extent that it would bind in film gates designed to pass film with the width of 0.630 inch. The manufacturers, therefore, were compelled to slit at the lower edge of the tolerance permitted by the American Standard. Variations in their slitting width, however, sometimes produced film slit below the limits of the standard.

For this reason an alternate standard has been adopted for this low-shrink film in order that the manufacturers may slit within the standard and still produce film which does not exceed 0.630 inch even at high humidities.

For the purpose of this specification, low-shrink film base is film base which, when coated with emulsion and any other normal coating treatment, perforated, kept in the manufacturer's sealed container for 6 months, exposed, processed, and stored exposed to air not to exceed 30 days at 65° to 75° and 50 to 60% relative humidity and measured under like conditions of temperature and humidity, shall have shrunk not more than 0.2% from its original dimension at the time of perforating.

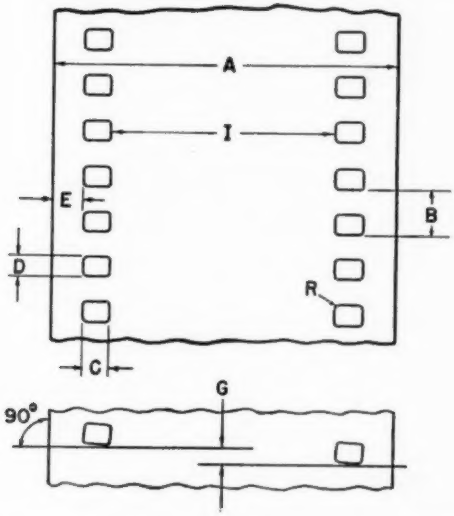
This definition of low-shrink film is to be used as a guide to film manufacturers, and departure therefrom shall not be cause for rejection of the film.

NOT APPROVED PH22.17

Proposed American Standard

Dimensions for 35mm Motion-Picture Positive Raw Stock

PH22.36
Revision of Z22.36–1947



Dimensions	Inches	Millimeters
A	1.377 ± 0.001	34.98 ± 0.03
B	0.1870 ± 0.0005	4.750 ± 0.013
C	0.1100 ± 0.0004	2.794 ± 0.01
D	0.0780 ± 0.0004	1.98 ± 0.01
E	0.079 ± 0.002	2.01 ± 0.05
*G	Not > 0.001	Not > 0.025
I	0.999 ± 0.002	25.37 ± 0.05
‡L	18.70 ± 0.015	474.98 ± 0.38
R	0.020	0.51

These dimensions and tolerances apply to the material immediately after cutting and perforating.

This film is used for motion picture prints and sound recording.

‡ This dimension represents the length of any 100 consecutive perforation intervals.

* Method of indicating G is the main change from Z22.36–1947.

NOT APPROVED

Appendix

The dimensions given in this standard represent the practice of film manufacturers in that the dimensions and tolerances are for film immediately after perforation. The punches and dies themselves are made to tolerances considerably smaller than those given, but owing to the fact that film is a plastic material, the dimensions of the slit and perforated film never agree exactly with the dimensions of the punches and dies. Shrinkage of the film, due to change in moisture content or loss of residual solvents, invariably results in a change in these dimensions during the life of the film. This change is generally uniform throughout the film.

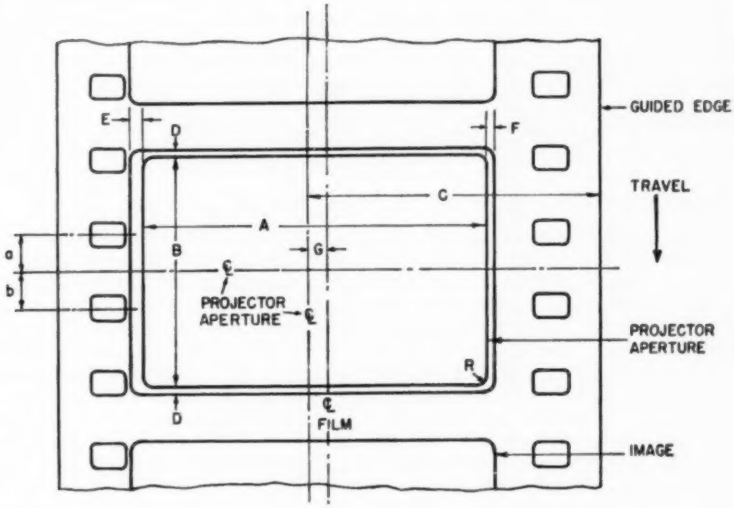
The uniformity of perforation is one of the most important of the variables affecting steadiness of projection.

Variations in pitch from roll to roll are of little significance compared to variations from one sprocket hole to the next. Actually, it is the maximum variation from one sprocket hole to the next within any small group that is important.

Proposed American Standard

Aperture for 35mm Sound Motion-Picture Projectors

PH22.58
Revision of Z22.58–1947



Dimension	Inches	Millimeters
A	0.825 ± 0.002	20.95 ± 0.05
B	0.600 ± 0.002	15.25 ± 0.05
C	0.738 ± 0.002	18.74 ± 0.05
D	0.0155	0.394
E	0.028	0.71
F	0.015	0.38
G	0.049	1.24
R	Not > 0.005	Not > 0.13
a = b = ½ longitudinal perforation pitch.		

These dimensions and locations are shown relative to unshrunk raw stock.

Note: The aperture dimensions given result in a screen picture having a height-to-width ratio of 3 to 4 when the projection angle is 14 degrees.

NOT APPROVED

73d Semiannual Convention

This Convention reflected the current state of the arts and sciences which are the Society's interest: a great deal of attention to 3-D and panoramic production and exhibition, interest and attention to drive-in theater aspects, and a steady interest in television and high-speed photography. And also perhaps a reflection of the industry today is that the Convention was on the move: 6 of the 16 sessions were held away from the Hotel Statler which was Convention headquarters during the week of April 27 through May 2 at Los Angeles. The complete roster of the papers and sessions appears on the last pages of this *Journal*.

Opening the Convention and summarizing much of what was on the minds or in the worries of those attending Monday's Get-Together Luncheon, the Society's President, Herbert Barnett, welcomed the 333 members and guests.

Get-Together Luncheon Remarks by President Barnett

"...The number of registrations thus far recorded and the gratifying attendance here today would indicate an unusually successful meeting. Several factors are responsible for these interesting prospects. A group of loyal local members have devoted much of their time to assure excellent technical sessions and social functions. Outstanding personalities have generously accepted our invitations to be present and speak to this luncheon session on matters vital to the industry as a whole. Additionally, we are presently experiencing one of the most intensive evolutions motion pictures have known. Not since the advent of sound has greater interest in motion pictures been evident than that which is now brought about through 3-D, wide-screen projection, and stereophonic sound.

"Motion pictures are front-page news as never before.

"Wherever you go, you hear discussions of the so-called new developments and everyone is anxious to see and be convinced that movies are on the way back.

"To the engineer this is even more strange in that all these things have been on the shelf for years. Yet it is understandable when we recognize that this industry appears to thrive on adversity. Faith in its future should be restored when one sees ability, as is being displayed today, to pick itself off the floor and come back strong and aggressive — perhaps not exactly the same in all respects, but at least a healthy, successful entertainment medium.

"In all this the motion-picture engineer must assume vast new responsibilities and there was never a better opportunity for him to act as a stabilizing element. There is recognizable potential danger in over-exploitation and hasty conclusions prompted by competitive ambitions and in the absence of overall industry considerations. The mass exhibition operation as we know it today will face disaster unless uniformity of equipment requirements is maintained — meaning, in other terms, that standardization must be an essential element of these developments. Standardization, not to the extent of stifling progress, but rather progressively to minimize the burdens that fall upon the exhibitor, as the final salesman of any motion-picture production.

"The Society stands ready — in cooperation with the Research Council — to offer services of its headquarters staff and its committees as a forum through which appropriate standards can be developed.

"We, as engineers, should exert our every influence to convince management and operations people that what has been done is only a start in the direction of improved entertainment value.

"To rest on present laurels could very well mean destruction of the vast prospects before us. Present trends should signal research needs this industry has not been aware of before. And in the throes of this new interest in 3-D, wide-screen and the like, we should not overlook the import

of television and its potential as a supplement to motion pictures.

"We would not minimize the exciting possibilities offered by these new media. But it may be well to temper enthusiasm with the sound and sobering fact that no matter what form motion pictures of the future take — 2-D, 3-D, wide-screen, curved screen or combinations — none of these will revive the industry unless the chosen system is supported by high-quality pictures made for entertainment purposes. We should be confident of the future when sound engineering decisions are used to supplement true showmanship in offering the public what it wants to see."

The Get-Together Luncheon Guest Speaker was Mitchell Wolfson. Mr. Wolfson's cogent speech was published in the May *Journal*. The arrangements of the Luncheon were under Chairman Loren L. Ryder.

The 65 papers were garnered and arranged in the Program chiefly by Program Chairman Ralph Lovell, with assists by Editorial Vice-President Norwood Simmons chiefly for the special sessions for for CinemaScope at Twentieth Century-Fox and for 3-D and wide screen at Universal-International. The Program had the usual predominance of papers from the area of the Convention. The Program benefited from early planning and help by Papers Committee Chairman Bill Rivers and by the efforts of Vice-Chairmen Joe Aiken, Skip Athey, George Colburn, Gerry Graham and John Waddell. Chairman for High-Speed Photography for the Convention was Carlos Elmer who early arranged a group of 11 papers and an all-day field trip to the U.S. Naval Ordnance Test Stations' Morris Dam Test Facility at Azusa. A complete list of the papers is given in this *Journal*, pp. 751–754.

Those who attended the Convention appreciated throughout the week the large and careful job which was done by Local Arrangements Chairman Vaughn Shaner: to prepare in a thousand ways for moving unpredictable numbers of people about the city, to provide for a variety of forum and projection facilities in several different places, to entertain what proved to be the largest number of registrants ever for a Society Convention, to be hospitable and to be helpful in a lot of little emergencies for people away from home. It was a real organization which took care of the Convention crowd in what could otherwise have proved an immensely turbulent and unnecessarily trying week.

The Convention's total registration was 1333, of which 146 were ladies registrations.

Attendance at Sessions

Largest single convening for a technical session was the estimated 825 who gathered on Monday evening at the Academy Award Theatre for the Stereoscopic Motion-Picture Session. A total of somewhat more attended the four showings of CinemaScope given by Twentieth Century-Fox on Stage 6 at Fox Western Avenue Studios, where each demonstration and discussion period had to be limited to 300 persons, because of fire regulations. A similar limitation was in effect on Saturday when by running three consecutive presentations Universal-International was host to 650.

Attendance at the Tuesday afternoon stereoscopic session ranged from 328 down to 205 at the end of the session. Sessions which covered in part stereo sound, on Monday and Friday afternoons, had attendances ranging from 165 to 250.

Television sessions on Tuesday morning and evening attracted 211 who visited CBS Television City and attended the session there and a range of 155 to 275 during the evening session.

There was a solid group of about 65 in attendance at all high-speed photography sessions, despite some handicaps in meeting room arrangements at the hotel.

Papers on drive-ins, screen brightness and sound brought average attendances of 80. The general session on Thursday afternoon averaged 108 in attendance, and the film-processing session Thursday evening had an attendance of 139 to 216 for various papers.

From Tuesday through Friday, there were nine meetings of Engineering Committees. Reports of those activities appear regularly in the *Journal* in the Engineering Activities column prepared by Hank Kogel, Staff Engineer, and also periodically in reports of the chairmen of committees. An Editorial-Papers Committee Meeting reviewed papers plans for the Fall Convention, and John Frayne and his 75th Convention Committee met to review plans for the historical aspects for that convention.

Registration and Membership

The largest registration ever achieved for a Society Convention was made with a revamped system worked out by Convention Vice-President Jack Servies and the Society's Business Manager Sig Muskat. Into this system were fitted arrangements and controls for supplying bus tickets, viewing glasses and special identification tickets for sessions away from the Statler, including something new which was added after the Final Program went to press: a courtesy showing to Convention registrants of Cinerama on Thursday forenoon. Cinerama opened in Hollywood on the previous evening.

Registration was carried out under the Chairmanship of Robert Young who organized the following Committee: Howard Bell of Mole-Richardson Co., Walter L. Farley, Jr., of Eastman Kodak Co., Donald Prideaux of the Lamp Division of General Electric Co., and Petro Vlahos of the Motion Picture Research Council. Clerical assistance was supplied by Allen K. Pollock, Manager of the Los Angeles Convention and Visitors Bureau.

Accountant for the Convention was Arthur Johnson of Pathe Industries, Inc., assisted by Herman J. Herles of Sound Services, Inc.

A satellite of the Registration Desk was the Membership Desk which, under Jack Duvall who is Membership Chairman for the West Coast, obtained 66 applications for Society membership and dispensed a great deal of information about SMPTE. Assisting him were Forrest Jennings and Walter Getze, with special help by student members: Ken Miura and Jack Belsky of USC and Edith Gross of UCLA.

All the bus and other special tickets, the viewing glasses and courtesy passes were organized and dispensed at the Hospitality Desk which was under the direction of Betty Hartlane, Guest Relations Director for ABC-Hollywood. Assisting her from ABC were: Vance Humphreys, Jean Biscayart, Terry Croghan, Al McHardy, Dave Loring and George Crosland.

Hotel Reservations and Transportation arrangements were under the Chairmanship of Philip G. Caldwell.

The Ladies Program, arranged and conducted by Mrs. Vaughn Shaner, featured: a Luncheon at the Huntington Hotel in Pasadena and a visit to the Huntington Library on Tuesday; and on Thursday a visit to the Paramount Studio, including luncheon on the set of *Elephant Walk*.

Exhibits

A feature of this Convention was an arrangement for exhibits, particularly of equipment related to papers in the sessions. This special program was arranged and controlled by Thomas J. Gibbons. It brought to the Convention an opportunity for registrants to review equipment from 16 manufacturers and the wares of 2 publishers.

Projection and Public Address

Motion-picture shorts opening each session continued to be an attracting feature. These were arranged for and scheduled by Ted Fogelman.

Projection, both 35mm and 16mm, was carried out under M. B. Smith, Merle Chamberlin and A. Craig Curtis. On hand were two SMPTE Convention reliables to help with projection: Frank Erler and Clyde Cooley who always serve beyond the call of duty. Also helping were USC students T. O. Garringer and Frank Ruttencutter, with Don McIntosh serving on the High-Speed Photography Sessions.

A very helpful part of the shoulder to the wheel for making the sessions go was the contingent of USC students, under faculty adviser Herbert E. Farmer. The recruiting and scheduling of USC help as door guards and ushers and as helpers on projection and public address and recording were done by Ken Miura, Chairman of the USC Student Chapter. The

students who helped in this way included: Hal Arthur, C. J. Belsky, Stephen Coakley, George Cravens, Harry Dorsey, Bill Harnett, Stone Ishimaru, Dick Pollister, Al Richards, J. Reed Rummage, Herb Skoble, Don Wald and Frank Zuber.

Helping particularly on Public Address and Recording were USC Chapter members Ken Miura, Christopher Bristol, Roy George and Bill Leavenworth.

As was the case a year and a half ago, the Society was fortunate to have as Chairman of Public Address and Recording Ed Templin who made all the arrangements with the Statler to employ the Society's equipment to very good advantage. Ed had the help, in addition to the USC Chapter members, of the following from the industry: John Stark of Altec-Lansing, John Wasse of CBS, Jim Pettus of RCA, Chuck Lang of Warner Bros., John Jacobs of Westrex, Jean Valentino of MGM, Jim Larsen of Academy Films and Phil Thomas of Westrex.

The Society's public address and recording equipment has been repackaged by a task committee under George Lewin. A subsequent report will describe the committee's success.

For two "remote" meetings, held at the Academy Theatre, and for two concurrent sessions (high-speed photography), a double-tape system was supplied through the courtesy of Ralph Lovell at NBC. Helping with the equipment from NBC were Frank Pontius and Gordon Donald. For the session at CBS Television City, Herb Pangborn provided staff and equipment for tape recording.

Equipment and operation for tape recording of the descriptions and discussions for the showings of CinemaScope at Twentieth Century-Fox were arranged by Jim Corcoran. At Universal-International, similar service was supplied through the efforts of Les Carey.

The Convention Program generally and many specific items, particularly those of interest to the general public, received wide attention in the press, as a result of the energetic attention of Harold Desfor, Chairman of Publicity.

The highlight of the week's entertainment was the usual semiannual banquet and dance which were under the Chairmanship of Sid Solow. Attendance at the Banquet was 430. A particular feature of the Banquet was the announcement of the SMPTE Board of Governor's action on April 26, placing the names of J. Arthur Ball and Col. Nathan Levinson on the SMPTE Honor Roll. The citations are given in the following story.

SMPTE Honor Roll

At the Society's 73d Semiannual Banquet the announcement was made that its Board of Governors had added the names of two pioneers to the Honor Roll. This was done upon consideration of a report of the Honorary Membership Committee, Chairman Fred T. Bowditch, and members F. E. Cahill, Lloyd Thompson, William C. Kunzmann and Elmer Richardson. The achievements were described:

Joseph Arthur Ball

J. Arthur Ball had 44 United States Patents granted to him as sole inventor in many cases, and in some cases as joint inventor. He had granted to him many foreign patents as well and four published papers were authored by him.

These published documents record important and significant contributions to the technical art of color picture photography. These contributions reflect the originality of thinking required and the attention to detail of Mr. Ball's work. The wide scope of the important contributions to the technical art of color motion-picture photography, made by him during his professional career, are a tribute to his versatility and ability. The importance of Mr. Ball's scientific and professional work is emphasized by the fact that many of his important contributions have stood the test of time.

Of prime significance were Mr. Ball's contributions in association with Gerald F. Rackett to the three-strip color motion-picture camera and the necessary optical and mechanical parts, which he invented

to insure successful operation of the basic three-color camera. The three-strip color motion-picture camera was, and is, an outstanding contribution to the technology of the 20th Century. It displays Mr. Ball's combined talents in the fields of mechanical engineering, optical science and photographic art. These cameras, to which he devoted his skill and imagination, have been a basic contribution in making commercial color cinematography a part of the lives of all of the people in the world.

Laboratory facilities and techniques were also improved by the contributions of Mr. Ball. He successfully conceived and developed many film-processing machines, including light-control mechanisms, film printers, film-registering devices, as well as new and novel methods to facilitate the handling of motion-picture films. In a large measure, therefore, the material brought from the motion-picture photographic field, into the laboratory, was significantly improved by Mr. Ball.

It is fitting to note not only the enduring contributions of Mr. Ball, but also that in the true sense of the word he was a pioneer in his field. In the early days of color cinematography Mr. Ball was a leader. In the two-color practices, he was an artisan and craftsman of the highest order. He explored, and contributed to, two-color motion-picture photography by developing taking devices, and improved techniques for registering and cementing together two-color motion-picture films. By 1950, he was actively working on processes utilizing four and five subtractive color components.

It is safe to say that commercial realization of color motion-picture photography was greatly enhanced through Mr. Ball's developments and engineering achievements in the field of optics and particularly in the development of retardation plates and multiple-aperture light dividers. His interest and ability led him into nearly every technical phase of the art of color motion-picture photography. Part of his early work on dye-transfer techniques was instrumental in the development of high-quality color motion-picture release print manufacture. He contributed to the technique of making animated cartoons in color motion pictures by inventing a new cartoon cell. The diversity of his acquaintance with problems in color motion pictures is evidence of his skill.

Developments in the art of color reproduction have been contributed to by Mr. Ball's work in carbon-type color prints reproduced on paper, plastic or cloth, and mass reproduction methods therefor.

This summary serves only to highlight some of the significant contributions to color-picture progress made by Mr. Ball.

Nathan Levinson

Col. Levinson introduced the late Sam Warner to the sound motion-picture experimental work of the Bell Laboratories in the year 1924, and Warner Bros. started experimental work in sound motion pictures at the Vitagraph Studios in Brooklyn in 1925. After they were convinced that sound motion pictures were a reality, they leased the Manhattan Opera House in New York City, which became the first sound motion-picture studio in the industry and from the work done there under Samuel L. Warner and Col. Levinson, it was possible for Warner Bros. to present the first program of sound motion pictures to the public in the original Warner Theatre on Broadway, New York City, August 6, 1926.

Sound motion pictures were still in the experimental stage at that time. A few very fine short subjects had been made, but the only work done in connection with feature pictures consisted of the addition of musical scores to silent productions such as *Don Juan*, *The Better 'Ole*, etc. The services of competent engineering personnel to carry on this experimental work and extend it to the Hollywood Studios were required, and, after surveying the field of such men, Warner Bros. turned to Mr. Levinson. His entire work from a very early age had been devoted to communications engineering in wire and in wireless telegraphy.

Soon after Marconi discovered wireless, Mr Levinson entered this field, and, in 1906, when President Theodore Roosevelt visited the Panama Canal, Mr. Levinson was sent by his company aboard the battleship Louisiana to demonstrate the use of wireless, between two ships, to the President. This was the first time that

two battleships out of sight of each other communicated with each other.

His work with the U.S. Army, the U.S. Navy, Western Union, Marconi Wireless Telegraph Co. of America and the Mutual Telephone Co. of Hawaii took him to Alaska and Hawaii, where he supervised the building of wireless stations for the U.S. Government and commercial organizations. The stations in Hawaii enabled this country to communicate with Japan and the South Sea Islands.

Returning to the states in 1915, he was radio engineer at the Mare Island Naval Station for the planning and operation of various government radio stations on the coast. While there, he worked on the plan for the first electric drive for battleships, the first Naval radio direction finder and airplane catapults for naval vessels.

Although his early years were spent working with the Navy, when World War I broke out, he was commissioned by the Army as a 1st Lieutenant and ordered to duty in the office of the Chief Signal Officer. He supervised the building of the Signal Corps Radio Laboratories at Camp Alfred Vail, N.J., now Fort Monmouth, and there attained the rank of Major.

Major Levinson remained on active duty until August 1919, then remained active in the reserve. Upon request of the Signal Corps in 1932, he planned the organization and equipment tables for a photographic general headquarters unit. In laying out this organization, he also planned the absorption by the Signal Corps of motion-picture personnel from the motion-picture studios in Hollywood with the least possible disruption to any single studio, and the result of this planning proved to be so effective that in 1942, he was presented with a special Academy Award which was handed to him by the Chief Signal Officer of the Army for the Academy in recognition of a job well done over a period of nine years.

In December 1940, he was commissioned a Colonel in the Army of the United States and was active in Signal Corps reserve photographic work until health forced his honorable discharge in 1942.

Col. Levinson brought the first planned and coordinated Sound Department into the picture industry after joining Warner Bros. in 1926. Switching from disc recording to film in 1931, he installed an entirely new system for Warner Bros. with many improvements over such systems then in use by other studios. He again improved the recording of sound from photographic to magnetic film recording which was first used by Warner Bros. in March 1951.

Although he was head of Warner Bros. Sound Department, he had been active in most technical phases of that company. He was President of their subsidiary, the United Research Corp., President of American Camera Co. and Vice-President of Radio Station KFWB.

Just prior to his death, he planned a new color installation and with the assistance of Fred Gage and Albert Tondreau, developed WarnerColor, which is now being used by Warner Bros. on most of their color pictures.

New Index to Standards

All who use engineering standards should have this Index which in its eight full pages gives all American Standards in an index by subjects and in a list by numbers. Also shown are the status and stages of development of each. Dated February 1953, this index should replace the earlier one in all SMPTE binders of standards. The index is available at no charge to all who request it from Society headquarters, regardless of whether it is to go into a binder.

If you have an SMPTE (3-post) binder and would like to receive advance notice of all future new and revised standards, please advise Society headquarters.

The complete assembly of heavy binder and the 75 current standards is now available at $15.00 (plus 3% sales tax on deliveries within New York City; or plus $0.50 extra for postage on foreign orders).

Board of Governors Meeting

Highlights of the April 26 meeting will be briefly projected. Fill-light, if not even more illumination, is provided by the next item in this *Journal*, a general report by the Executive Secretary. This was the first item on the Board's agendum.

An oral report by Treasurer Kreuzer was approved and followed by Board discussion of convention registration fees, membership dues in arrears and the investment of Society funds. The Board, in accordance with the suggestion of Peter Mole, instructed the Executive Committee to act at appropriate times to decide whether the Treasurer should reinvest the funds of maturing government bonds in current bond issues or in savings and loan accounts.

Following approval of Henry Hood's report as Engineering Vice-President, there was discussion of the need for the Society to be active in standardization for stereo pictures and sound. After observing that it is during the time of new developments that the Society serves greatly by supplying a forum where differences are clarified and understanding developed, it was pointed out that the Society should lead the way in setting standards, but without favoring one system over another.

The desirability of better coverage of new developments by the *Journal* was accented by reports about members who have complained locally that information reaches them too late. Mr. Nemec explained that resources of the *Journal* staff and the production time needed have precluded seeking any great amount of material that would require special preparation. He suggested that a Technical Progress Board is needed, with sections in Hollywood, Chicago and New York, which would meet once a month for lunch and write a letter to the *Journal*, reporting new developments.

The report of Editorial Vice-President Simmons was approved as submitted. This included a 7-page Analysis of the SMPTE Membership Service Questionnaire of early 1953 (this tabulation is to appear in the next issue of the *Journal*), a reiteration of editorial policies and the recommendation that the number of *Journal* pages for this year be increased by 20% and that one person be added to the staff, these last to be covered by a $10,500 increase in the publications budget.

William H. Offenhauser Jr. suggested that on certain new developments like stereophonic sound, bibliographies giving the background be published along with current articles to bring the subjects up to date. He also reported on membership promotion activities of the Atlantic Coast Section.

C. E. Heppberger reported briefly about the activities of the Central Section, commenting particularly on the benefits the section has derived from the practice of rotating chairmen for successive meetings.

In the absence of Vaughn Shaner due to illness, the Pacific Coast Section report was read by Henry Hood.

Convention Vice-President Servies reported first on the extent of the arrangements for the current convention, the reasons for the complicated local arrangements and the great success with which these were made by Mr. Shaner. The Board discussed the traffic problems and the admittance controls necessary for showings of CinemaScope, Cinerama and the Universal-International program. Second was the location of conventions. There was much sentiment for holding an occasional convention away from the usual large cities. Keeping in mind the time of year, the following were noted: Lake Placid, Silver Springs, Pinehurst, Colorado Springs and someplace in Canada. The Convention Vice-President was directed to plan holding a convention in such a location, without specifically obtaining Board approval, for not more than one convention in six.

After thorough discussion, the Board instructed that the Executive Committee rule on the matter of charging a higher convention registration fee and of issuing distinguishing badges for nonmembers.

As fully described just earlier in this *Journal*, two names were added to the Society's Honor Roll. The basis for establishing and augmenting the Honor Roll was reviewed. There was some questioning about the overall awards program of the Society, and John Frayne gave a brief

history of the awards, including formulation of the bases upon which they are made. Mr. D'Arcy observed that, in his opinion, it is becoming increasingly difficult to choose individuals for awards because business and research organizations are so much larger than they used to be, and so making awards to organizations may be in order. President Barnett asked for permission, which was granted, to appoint a committee from the Board to consider revision of the rules governing the several medals and to propose other medals if such are desirable. —*V.A.*

Report of the Executive Secretary

[As a part of the agendum for the spring meeting of the Society's Board of Governors, this summary of the general operation of the Society was presented by Boyce Nemec.]

The first quarter of 1953 was noteworthy for the volume of work entailed in serving members, the industry and the press. Many of the activities derived from the turbulence created by the sudden expansion of projection systems. Most of the extended functions, however, were normal steps of steady progress in the traditional business of the Society.

On the *publications* side there are several highlights:

• The organization and timely content of the Advance and the Final Programs of the 73d Convention.

• The enlarged *Journal* with its better supply of manuscripts.

• The Membership Service Questionnaire — the analysis of the returns has affirmed the value of the *Journal* to its readers and substantiated the wisdom of our editorial policy of continuing improvements to make it of maximum use to the maximum number.

• The *Journal*, besides the usual coverage of theoretical material, is meeting the immediate practical needs of individual engineers. Currently featured are color and theater television, stereoscopy, high-speed photography and magnetic striping.

• Worthy of note here is the prior attention given by the *Journal* to outstanding developments, now currently receiving wide attention. Some twenty years ago there was published in the *Journal* the foundation technical matter for the present wide-screen and three-dimensional processes. Considerable material on stereophonic sound was published beginning fifteen years ago.

• Reprints of papers and engineering reports in great demand have been supplied as part of a growing service to members and industry.

• A number of 3-D reports and instructions were published and disseminated among the exhibitor organizations, theater owners and operators, and other concerned groups.

• Our 1953 Plan of Operation called for the publication of special engineering studies written in nontechnical language for the benefit of exhibitors, businessmen and operating personnel. This project was organized and put into operation in January. Details will be reviewed below.

Engineering

The outstanding accomplishment of Engineering in the first quarter was negotiating final industry agreement on film-image areas for video recording for television film reproduction. This project is in the process for issuance as a standard.

Engineering activities have hit a new high, as have the activities of all other headquarters departments. All standards have recently been reviewed. Most of them have been reaffirmed; many have been revised; a few have been withdrawn. A number of new standards projects initiated last year have been developed to the stage of agreement. In consequence, there will be an increasing output of standards as the year unfolds.

Among the proposed standards being developed are those in cooperation with the Motion Picture Research Council for stereo motion pictures. These include nomenclature in general, identification of 3-D film and release-print leader, projector alignment for different screen widths, magnification, and basic nomenclature in stereoscopic transmission.

There has also been active work with the International Standards Organization on Cinematography. Progress in this joint effort has approached the point of submitting international standards proposals.

The Society has had a representative at demonstrations of the new projection processes, at the Theater Television hearings in Washington, and at all vital industry meetings. These were as diverse as wide-screen tests at Radio City Music Hall and MPA's conference on 3-D problems of exchanges.

Test film production was transferred in February to the West Coast. Fred Whitney supervised the installation and remained with it until production was under way. The first shipment of films from the West Coast has been received and the Society has made substantial shipments on contracts.

A new 3-D Test Film, developed by the Research Council for aligning two 35mm projectors to show any of the two-film stereo pictures now in release, was based upon the Society's familiar Visual Test Film.

Stereoscopic Motion Pictures

While it is not the Society's duty to plot the course of engineering progress in advance, the Society has endeavored to anticipate the potential technical needs of 3-D systems. In addition to the considerable stereo and wide-screen data in the *Journal* over the past quarter-century, there has been a great variety of intelligence exchanged through correspondence and conferences.

Anticipating the heavy demands on the Society for information on the new developments, we began in January to prepare a series of articles, nontechnical reports, illustrated lectures, operating instructions, trade-paper and press releases, and public- and industry-relations addresses by President Herbert Barnett.

Wild and confusing claims plus misinformation had the punch-drunk exhibitors hanging on the ropes. They needed help. We called and held a conference of the major exhibitor organizations on February 5. The Society was represented by the President, the Engineering Vice-President, the Chairman of the Stereoscopic Motion Pictures Committee, the Executive Secretary and the Staff Engineer. This meeting covered the whole field of 3-D and wide-screens from the standpoint of the exhibitor. A substantial report of this meeting appeared in the February *Journal* and subsequent reports by the Staff Engineer have brought concrete data and news to the membership. A Progress Report on New Developments was mailed to the industry on April 15 and on April 21 detailed Projection Instructions for 3-D shows, prepared by the Research Council, were sent to exhibitors and theater-owner organizations.

Meanwhile, President Barnett spread the Society's messages on the convention front. He made three important addresses on the new developments at a meeting of projectionists in New York, and at theater-owner conventions in Milwaukee and Columbus, Ohio. The approbation of the press and industry has proved that Mr. Barnett's speeches did much to resolve the confusion in the field and augment the prestige of the Society.

Membership Activities

Every facet of the membership situation has been explored and a broadened program has been developed and put to work. The primary mission of this effort is to increase membership at a minimum cost per member.

Individual members were previously obtained chiefly at conventions and at section meetings. A hard-hitting, fast-reading membership brochure has been prepared with a revised application form. With a suitable letter covering procedure, this booklet with enclosures carrying added information about the Society is ready for mailing to each member. Thus, at a peak of our publicity, the members are asked to recommend and sponsor a desirable applicant. And with all the tools at hand to make the task an easy one, we expect to attain our goal of a thousand new members this year.

Additionally, we have invited the applications of members of The Screen Directors' Guild and the American Society of Cinematographers. We laid the groundwork for this by invitations to attend our Convention and by stressing our keen desire to share information of benefit to their membership and the industry as a whole.

Considerations of headquarters work load forced us to delay the Sustaining Members drive. However, current events in

the industry make this a proper time to get under way. With the experience of the last few months to draw upon, we have prepared a "sales" folder which tells sustaining members what the Society is doing, and can do, for them. Personalized letters of transmittal, dealing with the specific interests of each member and firm, have been drafted.

Public, Industry and Press Relations

The Society's Plan for the current year emphasized the numerous public relations activities necessary to meet our mounting obligations and to serve the industry under the conditions that will exist for some years to come.

For the first time in its history, the Society has embarked on a planned course of action in public relations. Briefly, these are the phases of the campaign:

- A Technical Information Service, starting as a minor matter of answering mailed and phoned questions, has mushroomed into a major activity, both in time consumed and in importance. Headquarters has become the clearinghouse for technical matters. Much of the time of the Executive Secretary and the Staff Engineer is devoted to this necessary and important task. When the advice requested exceeds our province, we of course recommend that the services of a consulting engineer be obtained.
- Another part of our public-relations effort is concerned with active participation with other technical societies and with trade and cultural groups with legitimate motion-picture and television interests.
- As mentioned above, under publications and under stereo, we are endeavoring by the numerous ethical means to publicize the services and activities of the Society. Through carefully prepared addresses and a series of reports and trade-press releases, we are performing an essential job while building up public knowledge and esteem for the Society.
- The purpose behind this build-up is manifold. More information about the Society will attract new members. It will tend to arouse the interest of undergraduate engineers working in the industry. It acts to widen the influence, and therefore the value, of the Society. It bolsters prestige of individual members in their daily work. And already it has clearly strengthened the bond between the Society and the various segments of the motion-picture and television industry.

President Barnett's May 5th address at Minneapolis is another important step in the campaign, and still another Society Speaker is featured at the Central Atlantic Optometric Assembly of May 29. This is part of a joint campaign of the motion-picture and optometric fields to educate the public about viewing stereo films. Still another speaker will star at the Convention of the American Psychological Association in Cleveland in September.

As soon as is possible, the information available from the Convention will be integrated into the material already in preparation so that we can distribute the first booklets in nontechnical language on projection of stereo and wide-screen pictures. Another publication will follow on the production of these processes. Then will come the illustrated lectures on these systems.

These efforts, in short, are but highlights of our daily campaign to have the Society take its rightful place at the head of our industry's technical groups. In that high position, the next three or four years will provide the Society with a remarkable opportunity to prove its worth.—*Boyce Nemec.*

Central Section Meeting

An afternoon, dinner and evening meeting was held on Thursday, May 21, beginning at 3:00 P.M. at the Western Society of Engineers in Chicago. Attendance at this very successful meeting was: 125 in the afternoon, 65 for dinner and 135 in the evening.

Called "Applications of Magnetic Recording to Motion Pictures," the program had these features:

"Magnesound Unit," Walter Vance, Victor Animatograph Corp., Chicago.

"Movie Sound 8 Projector," Lloyd Thompson, The Calvin Co., Kansas City, Mo.

"Model 25B Portable Magnetic Film Recorder," Harold L. Powell, Hallen Corp., Burbank, Calif.

"Compacting a Field-Type Magnetic Film Sound Recorder," Otto Hangartner Jr., Magnasync, Chicago.

"Model 477 16mm Optical-Magnetic Recording Projector," J. J. Graven, Ampro Corp., Chicago.

"RCA Model 400 Magnetic Recorder Projector," W. G. Dwinell and R. T. Van Niman, RCA Victor Div., Camden, N.J.

"Bell & Howell Model 202 Optical-Magnetic Sound Projector," M. G. Townsley, Bell & Howell Co., Chicago.

"Simplified Stereophonic Sound," Richard H. Ranger, Rangertone Inc., Newark, N.J.

"Fundamental Principles of Magnetic Recording," W. W. Wetzel, Minnesota Mining & Mfg. Co., St. Paul.

"Panel Discussion With Audience Participation," with a panel ready to answer questions: Marvin Camras, E. W. D'Arcy, R. H. Ranger, M. G. Townsley and W. W. Wetzel.

Comments received from members indicate that this type of meeting is wanted at least once a year.—*James L. Wassell*, Secretary-Treasurer, Central Section, 247 E. Ontario St., Chicago 11.

ASLIB

Aslib, formerly known as the Association of Special Libraries and Information Bureaux, was established in 1924 to facilitate the coordination and systematic use of information in commerce, industry and the academic world. It acts as an intelligence service for putting its members, who are all users of information, in touch with special and technical knowledge on every subject.

The scope of Aslib's activities is indicated by the services it offers to members: the Information Bureau undertakes to find the right source for any information that is required within a short time; an index of unpublished translations is maintained as well as a panel of specialist translators; help is given on all matters relating to documentation and many books, periodicals and reports may be borrowed from the library; the Document Reproduction Service supplies photocopies or microfilms of documents at reasonable rates; authoritative advice is given on establishing and developing information services and special libraries; an employment register of candidates and posts in information departments and special libraries is maintained for the use of members.

Apart from these day-to-day activities and as part of a long-term policy, Aslib encourages the use and expansion of information services and special libraries by arranging training courses, holding meetings throughout the year, forming subject groups for workers in special fields and maintaining close and friendly contact with such bodies as UNESCO and the International Federation for Documentation, of which Aslib is the British member. Aslib publishes works of reference which include the forthcoming *British Scientific and Technical Books: a select bibliography* and the annual *Index to Theses Accepted for Higher Degrees in the Universities of Great Britain and Ireland*, but the principal means by which Aslib members are kept informed of the latest developments are by its three periodical publications. The Central Book Company, Inc., 261 Broadway, New York 7, N.Y., acts as agent for these in the U.S.A. The periodicals are: *The Journal of Documentation*, annual subscription \$6, is a scholarly quarterly devoted to the recording, organization and dissemination of specialized knowledge and everything that is meant by the term "documentation"; *Aslib Proceedings*, annual subscription \$6, also a quarterly, contains conference reports and papers given at Aslib meetings throughout the year; *Aslib Book-List*, annual subscription \$3.50, is a monthly list of technical and scientific publications in the English language selected and recommended by specialists in each subject field.

The offices of Aslib are at 4 Palace Gate, London, W.8, England.

Book Review

Writing for Television

By Gilbert Seldes. Published (1952) by Doubleday & Co., Garden City, N.Y. 254 pp. $5\frac{3}{8} \times 8\frac{1}{4}$ in. $3.00.

Readers who know Mr. Seldes' previous work — plays, motion picture, radio and television scripts and some 10 books — will know, especially from *The Seven Lively Arts* and *The Great Audience*, a little of what to expect in this new volume. This is a practical book but it is by no means solely a quick how-to-do-it manual. Although the author's experience and activities have been pragmatical, and his book reflects this, there is also a good deal about the science of writing, something which used to be called a philosophy of writing. For one small sample, we quote:

"The writer of an educational program on anthropology does not have to be an anthropologist nor the writer on chemistry a chemist. He has to know television and he has to know how to write. Beyond that the basic requirement is that he must have intelligence enough to understand what the anthropologist or chemist wants to convey on the program."

Although the author calls his book one of craftsmanship, not of inspiration, it is perhaps better to call it thoroughly educational. In the first section the reader will find orientation for television writing; then come sections on conditions the writer must meet, general rules of dramatic writing, types of drama, nondramatic programs, and, finally, professional problems. Examples of content and physical arrangements of scripts are given, as well as many references, examples or data about the technical aspects which the writer cannot ignore.

There are books which present the techniques of television writing more simply and such books may be more quickly useful. Mr. Seldes' book will be most rewarding if it is read straight through, to provide a writer with an overall review of his profession, then referred to in detail for pointers to sharpen his craft.—*V.A.*

Exposure Meters and Practical Exposure Control

By J. F. Dunn. Published (1952) by The Fountain Press, 46–47 Chancery Lane, London WC2, England. 252 pp. (incl. 10 pp. index) + 8 pp. adv. Numerous tables; 97 illus. and plates. 612 × 812 in. Price 35 shillings.

To the above bibliographical data, as given in the February 1953 *Journal*, should be added:

Distributed in U.S.A. at $7.75 by Publication Dept., Rayelle Foreign Trade Service, 5700 Oxford St., Philadelphia 31, Pa.

New Members

The following members have been added to the Society's rolls since those last published. The designations of grades are the same as those used in the 1952 Membership Directory.

Honorary (**H**) Fellow (**F**) Active (**M**) Associate (**A**) Student (**S**)

Abe, Mikishi, Consulting Engineer and Architect, 10 Azabu-Miyamura St., Minato-Ku, Tokyo, Japan. (**A**)

Allen, Robert E. G., Free-lance Motion-Picture Sound Engineer. **Mail:** c/o New Zealand House, 415 The Strand, London, W. 1, England. (**A**)

Allen, W. Bryan, Motion-Picture Laboratory Technician, Lakeside Laboratory. **Mail:** 812 Vermillion St., Gary, Ind. (**A**)

Althouse, Charles S., Sound Production and Music Mixer, Hal Roach Studios. **Mail:** 1540 North Sierra Bonita Ave., Hollywood 46, Calif. (**A**)

Asher, John E., President, Lab TV, 1733 Broadway, New York 19, N.Y. (**M**)

Bach, B. J., Director, Treasurer, Cinesound Ltd., 553 Rogers Rd., Toronto 9, Ontario, Canada. (**A**)

Badler, Mitchell M., University of California at Los Angeles. **Mail:** 6109 Del Valle Dr., Los Angeles 48, Calif. (**S**)

Baker, Friend F., Camera Engineer, Mark Armistead, Inc. **Mail:** 1037 North Orange Grove Ave., Hollywood, Calif. (**M**)

Baldwin, Kenneth, Motion-Picture Production Supervisor and Editor, Marathon TV Newsreel, 125 E. 50 St., New York 22, N.Y. **(A)**

Bangs, Philip C., Owner and Chief Engineer, Acoustic Equipment Co., 323 Walton Bldg., Atlanta, Ga. **(A)**

Becker, C. H., Director of Research, Ampex Electric Corp., 934 Charter St., Redwood City, Calif. **(A)**

Bennett, Lee, President, Bennett & Co., Inc., 312 Forsyth Bldg., Atlanta, Ga. **(A)**

Bernier, Jane, President, Synthetic Vision Corp., 9501 North Main St., Riverdale Station, Box 4, Dayton 5, Ohio. **(A)**

Bordwell, Charles E., Motion-Picture Producer, John Sutherland Productions, Inc., 201 North Occidental Blvd., Los Angeles 26, Calif. **(M)**

Brandsma, Walter C., Chemical Engineer, Supervisor, Photo Products Dept., E. I. du Pont de Nemours & Co., Parlin, N.J. **(M)**

Bright, S/Sgt. Wesley Jr., Senior Motion-Picture Specialist, U.S. Air Force. **Mail:** 813 South Sixth St., Louisville, Ky.**(A)**

Brodersen, Gerald D., Assistant Laboratory Superintendent, Hollywood Film Enterprises, Inc. **Mail:** 10402 Tiara St., North Hollywood, Calif. **(M)**

Brown, Lyle O., Chemical Engineer, Eastman Kodak Co., 1712 South Prairie Ave., Chicago, Ill. **(M)**

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Conover, Donald W., Research Psychologist (Visual Displays — CR Tubes), U.S. Navy Electronics Laboratory, Human Factors Division, San Diego 52, Calif. **(M)**

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Cox, Thomas, Motion-Picture Cameraman, U.S. Air Force. **Mail:** 212 Reeves Dr., Beverly Hills, Calif. **(A)**

Cramer, Harold W., Manufacturer, Cramer Posture Chair Co. **Mail:** R. R. 2, Hickman Mills, Mo. **(A)**

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Daugherty, C. F., Radio Engineer, Atlanta Newspapers, Inc., WSB, WSB-TV, Biltmore Hotel, Atlanta, Ga. **(A)**

Dedrick, Robert L., Senior Staff Photographer, Pilot Productions, Inc., 6419 North California Ave., Chicago, Ill. **(A)**

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Hone, Francis J., Physicist, J. A. Maurer, Inc., 37-01 — 31 St., Long Island City, N.Y. **(A)**

Hynes, Fred, Transmission Engineer, Sound Services, Inc. **Mail:** 432 South Curson Ave., East, Apt. 4K, Los Angeles 36, Calif. **(A)**

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Koch, J. Wesley, Chief Engineer, KFEQ-TV, KFEQ Bldg., St. Joseph, Mo. **(A)**

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Lassiter, Darrell D., Chief, Film Processing Laboratory, White Sands Proving Grounds, Las Cruces, N.M. **(A)**

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Mangolds, Boris, Engineer, Mark Electronics, Inc., 86 Shipman St., Newark 2, N.J. **(A)**

Marchev, George B., Manufacturer, Gordos Corp., 86 Shipman St., Newark 2, N.J. **(A)**

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Moore, Robert L., Film Editor, Syracuse University, Syracuse 10, N.Y. (**A**)

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Pauley, Alfred J., Superintendent, Engineering, Maintenance and Purchasing, Odeon Theatres (Canada) Ltd. **Mail:** 199 Bayview Ave., Toronto, Ontario, Canada. (**M**)

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Segal, Sam J., Partner, Owner, Projection Service & Supply Co., 111 N. 11 St., Minneapolis 3, Minn. (**M**)

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Siegel, Nathan, Chief, Projection and Sound Engineer, Cinerama Productions, Inc. **Mail:** 2085 Matthews Ave., Bronx 60, N.Y. (**M**)

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Simon, David H., Cornell University. **Mail:** 411 University Ave., Ithaca, N.Y. (**S**)

Skinner, John P., Manager, Magnetic Recording, Armour Research Foundation, 35 W. 33 St., Chicago 16, Ill. (**A**)

Smith, Robert W., Photographic Technician, General Motors Proving Grounds. **Mail:** 606 South Main St., Milford, Mich. (**A**)

Spira, S. Franklin, Retailer, Spiratone, Inc. **Mail:** 32-15 — 35 St., Long Island City 3, N.Y. **(A)**

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Stevens, Jack, Photographer, 205 West 'F' St., San Diego 1, Calif. **(A)**

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Wedmore, Basil T., Electrical Engineer, Westrex Corp. **Mail:** 491 Linden Pl., Orange, N.J. **(M)**

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Wolfson, Mitchell, Co-owner, Wometco Theatres and Station WTVJ Television, P.O. Box 2440, 306 North Miami Ave., Miami, Fla. **(A)**

Wright, Thomas H., Motion-Picture Sound Recordist, The Jam Handy Organization. **Mail:** 7518 Robinwood, East, Detroit 34, Mich. **(A)**

Zeff, Paul, Chemist and Sensitometrist, Columbia Pictures Corp., Hollywood 25, Calif. **(A)**

Zipser, Sidney, Camera Technician, Technicolor Motion Picture Corp. **Mail:** 11547 Kelsey St., North Hollywood, Calif. **(A)**

CHANGES IN GRADE

Anderson, Karl R., (S) to (A)
Bodkins, Arthur I., (A) to (M)
Braverman, Isadore R., (S) to (A)
Davis, Charles C., (A) to (M)
Dialon, J., (S) to (A)
Gaylord, James L., (A) to (M)
Gioga, Peter C., (A) to (M)
Isom, Warren R., (A) to (M)
Jope, Howard E., (A) to (M)
Kotis, Arnold F. T., (A) to (M)
Lane, Robert W., (S) to (A)
Lemmon, Gene C., (A) to (M)
Luckey, Richard S., (S) to (A)
MacDonald, Joseph W., (S) to (M)
Masters, Richard M., (S) to (A)
Miller, Joseph F. G., (A) to (M)
Nass, Leonard I., (S) to (A)
Negus, George T., (A) to (M)
Papin, Ralph L., (S) to (A)
Purdy, Clarence A., (A) to (M)
Stevenson, Paul J., (S) to (A)
Tetard, John C., (A) to (M)
Walker, Algernon G., (A) to (M)
Warren, Dave, (S) to (A)

DECEASED

Gowar, Rupert E., Manager, Westrex Company, East, P.O. Box 893, Alexandria, Egypt. **(A)**

Havill, Percy C., Projectionist, Beck Theatre Corp. **Mail:** 918 Sunnyside Ave., Chicago, Ill. **(A)**

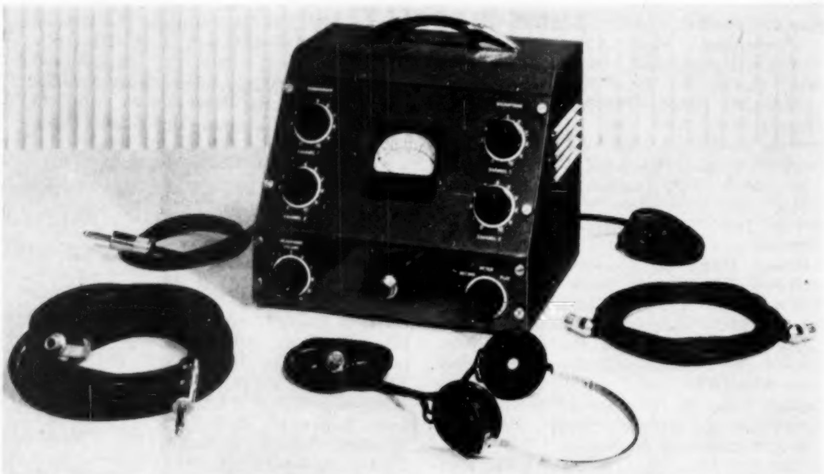
Shaftan, Kenneth, Director, Photographic Instrumentation Div., J. A. Maurer, Inc., 37-01 — 31 St., Long Island City, N.Y. **(M)**

Shamray, Peter L., Technical Representative, du Pont Motion Picture Film. **Mail:** Box 16336, Vine Station, Los Angeles 38, Calif. **(M)**

SMPTE Officers and Committees: The roster of Society Officers and the Committee Chairmen and Members were published in the April *Journal*.

New Products

Further information about these items can be obtained direct from the addresses given. As in the case of technical papers, the Society is not responsible for manufacturers' statements, and publication of these items does not constitute endorsement of the products.



A new Bell & Howell Electronic Mixer and Volume Control is now available for users of the Filmosound 202 16mm magnetic recording projector. Designed to provide simple and accurate means of mixing sound signals from microphones, phonographs and tape recorders, four separate input channels permit their mixed use in any desired combination. There is an illuminated volume-level meter on the front panel for setting the recording level at any time. The meter is calibrated directly in volume units. A set of matching headphones is supplied as standard with the equipment which has a list price of $140.00 and is now available from Bell & Howell dealers.

A series of three pocket-size volt-ammeters, in a range that measures up to 1200 amp, is now available from the Pyramid Instrument Corp., Lynbrook, N.Y. These are "snap-around" type designed for measuring current without connecting to the conductor. Pointed jaws have been made for working in crowded switch and terminal boxes. The voltage test leads have been equipped with a newly designed retractible safety plug, and the probe jaws are completely insulated down to the sockets. Prices range from $49.50 to $67.50.

The RCA TV-Eye consists most importantly of a 4-lb camera developed by the RCA Laboratories Div. and expected to be commercially available in September. With a control box which brings the equipment's weight up to nearly 20 lb, it operates on a closed circuit with a standard domestic receiver as monitor and is tied in to an otherwise unused channel, without interfering with reception on other channels. It is expected that this "private-line TV" will prove useful in schools, hospitals, prisons, stores, small factories and even in homes. It was demonstrated during the May Electronic Parts Show at the Conrad Hilton Hotel in Chicago by focusing the camera on a bulletin board at the central message center and showing the messages on a dozen receivers at exhibition points throughout the hotel.

Employment Service

These notices are published for the service of the membership and the field. They are inserted for three months, and there is no charge to the member.

Positions Available

Wanted: Motion-picture processing technicians for employment at U.S. Naval Ordnance Test Station, China Lake, Calif. Operators of Models 10 and 20 Houston motion-picture processing machines, and operators of Bell & Howell Models "D" and "J" motion-picture printers are needed. Civil Service positions — $3,410 per annum base pay. Family housing limited; single persons preferred. Obtain Form 57 from any U.S. Post Office, fill out in detail, and mail to Carlos H. Elmer, 410B Forrestal, China Lake, Calif.

Senior Engineer with leading supplier of motion-picture and TV equipment is looking for an associate in the development of film and tape handling equipment and other fine electromechanical devices. Give résumé of professional experience and range of interest and accomplishments by letter to W. R. Isom, 1203 Collings Ave., Oaklyn, N.J.

Wanted: Two design engineers, must be familiar with camera and precision instrument design. A working knowledge of machine shop practice essential. Salaries commensurate with ability. Send résumé of experience and personal details in letter to: Land-Air Inc., 900 Pennsylvania Ave., Alamogordo, N.M.

Wanted: 1 Film Editor and 3 Photographic Processing Technicians, by the Employment Office, Atten: EWACER, Wright-Patterson Air Force Base, Ohio.

Film Editor, GS-9: Must have 5 yrs. experience in one or more phases of motion-picture production. Experience must include at least 1½ yrs. motion-picture film editing with responsibility for synchronization of picture, narration, dialogue, background music, sound effects, titles, etc. $5060 yr.

Photographic Processing Technician (Color) GS-7: 6 yrs. progressively re-

sponsible experience in motion-picture photography and/or photographic laboratory work, involving essential operation of film processing. Eighteen months of this experience must have involved processing of color film. $4205 yr.

Photographic Processing Technician (Black-and-White) GS-7: 6 yrs. progressively responsible experience in motion-picture photography and/or photographic laboratory work, involving essential operation of film processing. $4205 yr.

Photographic Processing Technician (Black-and-White) GS-5: 2½ yrs. progressively responsible experience in motion-picture photography and/or photographic laboratory work, involving essential operation of film processing. $3410 yr.

Positions Wanted

TV Cameraman-Director, year's experience as cameraman, asst. stage manager and lighting director; manager, small studio and director of 15-min fill-in TV shows, up to 5 shows weekly, mostly educational TV programs, also daily illustrated newscast, at LR3 Radio Belgrano TV, Buenos Aires, Argentina. Experienced in still and live commercials. Born in U.S., age 26, single, B.A. Hunter College (1951). Veteran, World War II. Desires position with TV station anywhere in U.S. or Latin America; willing to travel. Fluent Spanish. Particularly interested in educational TV, nevertheless, will accept any type of TV work related to experience offered. References, résumé, etc., available on request. Write *airmail* to Stanley E. Lustberg, Jose Everisto Uriburu 1551, Buenos Aires, Argentina.

Picture Optical Printer Available With Operator: Modern complete machine 35mm to 35mm and 16mm to 35mm using Acme Projector and Camera, registration to 0.0001 in., including many accessories, synchronizers, etc. Over 200 TV commercials, many features and blow-ups in color and B&W. Represents $20,000 investment. Owner-operator has long experience with Hollywood major studios. Can double as cameraman. Reasonable. Contact Wm. G. Heckler, 245 West 55 St., New York, N.Y. Phone: Plaza 7-3868.

Meetings

PSA Convention (Photographic Society of America), includes a "Color Round Table" sponsored by the PSA Technical and Color Divisions, Aug. 3–8, Biltmore Hotel, Los Angeles

WESCON (Western Electronic Show & Convention), Aug. 19–21, Civic Auditorium, San Francisco

Biological Photographic Association, 23d Annual Meeting, Aug. 31–Sept. 3, Hotel Statler, Los Angeles, Calif.

Illuminating Engineering Society, National Technical Conference, Sept. 14–18, Hotel Commodore, New York, N.Y.

The Royal Photographic Society's Centenary, International Conference on the Science and Applications of Photography, Sept. 19–25, London, England

National Electronics Conference, 9th Annual Conference, Sept. 28–30, Hotel Sherman, Chicago

74th Semiannual Convention of the SMPTE, Oct. 5–9, Hotel Statler, New York.

Audio Engineering Society, Fifth Annual Convention, Oct. 14–17, Hotel New Yorker, New York, N.Y.

Theatre Equipment and Supply Manufacturers' Association Convention (in conjunction with Theatre Equipment Dealers' Association and Theatre Owners of America), Oct. 31–Nov. 4, Conrad Hilton Hotel, Chicago, Ill.

Theatre Owners of America, Annual Convention and Trade Show, Nov. 1–5, Chicago, Ill.

National Electrical Manufacturers Association, Nov 9–12 Haddon Hall Hotel, Atlantic City, N.J.

75th Semiannual Convention of the SMPTE, May 3–7, 1954, Hotel Statler, Washington, D.C.

76th Semiannual Convention of the SMPTE, Oct. 18–22, 1954 (next year), Ambassador Hotel, Los Angeles

Papers Presented at the Los Angeles Convention, April 27 – May 1

(**By Sessions**)

MONDAY NOON—**Get-Together Luncheon**

Mitchell Wolfson, Wometco Theatres, Miami, Fla., "The Motion-Picture Industry."

MONDAY AFTERNOON—**Stereo Sound and Sight Session**

Harvey Fletcher, Brigham Young University, Provo, Utah, "Stereophonic Recording and Reproducing System—Historical and General Theory."

Lorin D. Grignon, 20th Century-Fox Film Corp., Beverly Hills, Calif., "Stereophonic Recording for Motion Pictures."

R. A. Sherman, Bausch & Lomb Optical Co., Rochester, N.Y., "Beneficial Effects of Properly Produced and Projected Stereoscopic Motion Pictures on Binocular Visual Performance."

MONDAY EVENING—**Stereoscopic Motion-Picture Session**

John A. Norling (Committee Chairman), Loucks & Norling Studios, New York, "Stereoscopic Motion Pictures Committee Report."

William F. Kelley, Motion Picture Research Council, Hollywood, Calif., "Slide Demonstration of Stereoscopic Principles."

Loren L. Ryder, Paramount Pictures Corp., Hollywood, Calif.; Douglas Shearer, Metro-Goldwyn-Mayer Studios, Culver City, Calif.; William A. Mueller, Warner Brothers Pictures, Inc., Burbank, Calif.; and Stanley D. Horsley, Universal-International Studios, Universal City, Calif., "Excerpts From Major Studio Stereo Tests and Productions."

TUESDAY MORNING—**Television Session**

The 1354th Video Production Squadron, Air Photographic and Charting Service, MATS—USAF—exhibition held at CBS-TV City.

W. A. Palmer, W. A. Palmer Films, Inc., San Francisco, Calif., "Closed Circuit Video Recording for a Fine Music Program."

R. S. O'Brien, R. B. Monroe and P. E. Fish, CBS Television, New York, "CBS Television City Audio and Video Facilities."

George C. Izenour, Century Lighting Co., New York, "Control System for Stage and Television Lighting."

Tour of CBS Television City Plant.

TUESDAY AFTERNOON—**Symposium on Stereoscopic Motion Pictures**

John A. Norling, Loucks & Norling Studios, New York, "Stereo Camera Design."

Raymond J. Spottiswoode, Stereo Techniques, Ltd., London, England, "Space Control and the Use of the Stereo Window."

Armin J. Hill, Motion Picture Research Council, Hollywood, Calif., "Binocular Vision and the Perception of Projected Stereoscopic Pictures."

Merle H. Chamberlin (Moderator), Metro-Goldwyn-Mayer Studios, Culver City, Calif., "Panel Discussion on Projection and Exhibition of Stereoscopic Motion Pictures."

TUESDAY EVENING—Television Session

R. A. Isberg, Consulting Television Engineer, Palo Alto, Calif., "Increasing the Efficiency of Television Station Film Operations."

Louis N. Ridenour and George W. Brown, International Telemeter Corp., Los Angeles, Calif., "Fundamental Problems of Subscription Television; The Telemeter System."

I. J. Kaar, General Electric Co., Syracuse, N.Y., "The NTSC Color Television System."

Otto H. Schade, RCA Victor Division, Harrison, N.J., "Optical and Electrical Equivalents in Television and Photography, A Progress Report on Applications of Aperture Theory."

WEDNESDAY MORNING (Concurrent Sessions)
————Drive-In Theater and Film Editing Session

Ralph H. Heacock (Committee Chairman), RCA Victor Division, Camden, N.J., "Film-Projection Practice Committee Report."

Ralph H. Heacock, RCA Victor Division, Camden, N.J., "Improved Equipment for Drive-In Theaters."

J. R. Hoff, The Ballantyne Co., Omaha, Nebr., "Drive-In Theater Dub'l Cone In-a-Car Speaker."

Loren L. Ryder and Charles R. Daily, Paramount Pictures Corp., Hollywood, Calif., "Brighter Pictures for Drive-Ins."

G. R. Crane, F. Hauser and H. A. Manley, Westrex Corp., Hollywood, Calif., "Westrex Film Editor."

Walter H. Hicks, Centaur Products Corp., Manhasset, N.Y., "A Nonintermittent Photomagnetic Sound-Film Editor."

————High-Speed Photography Session

Mabry Van Reed, U.S. Naval Ordnance Test Station, Pasadena Annex, Pasadena, Calif., "Photography for High-Velocity Missile Tests at Morris Dam Test Range."

Field Trip to U.S. Naval Ordnance Test Station's Morris Dam Test Facility, Azusa, Calif.

WEDNESDAY AFTERNOON — Symposium on Screen Brightness

Frank F. Crandell, Photo Research Corp., Burbank, Calif., "The Spectra Brightness Spot Meter."

F. P. Holloway, R. M. Bushong and W. W. Lozier, National Carbon Co., Fostoria, Ohio, "Recent Developments in Carbons for Motion Picture Projection."

Lawrence D. Clark, Eastman Kodak Co., Rochester, N.Y., "Picture Quality of Motion Pictures as a Function of Screen Luminance."

L. A. Armbruster and W. F. Stolle, Eastman Kodak Co., Rochester, N.Y., "Optimum Screen Brightness for Viewing 16 mm Kodachrome Prints."

Raymond L. Estes, Eastman Kodak Co., Rochester, N.Y., "The Effects of Stray Light on the Quality of Projected Pictures at Various Levels of Screen Brightness."

THURSDAY AFTERNOON (Concurrent Sessions)
————General Session

A. J. Miller, Consolidated Film Laboratories, Ft. Lee, N.J., "Triple-Light-Source Printer for Color Films."

M. G. Townsley (Committee Chairman), Bell & Howell Co., Chicago, Ill., "Report of Committee on 16 mm and 8 mm Motion Pictures."

Linwood G. Dunn, RKO Radio Pictures, Hollywood, Calif., "An Example of Composite Cinematography."

E. K. Carver (Committee Chairman), Eastman Kodak Co., Rochester, N.Y., "Film Dimensions Committee Report."

Frank G. Back, Zoomar, Glen Cove, N.Y., "A New Zoomar Lens for 16 mm Motion Pictures."

K. G. Macleish, Camera Works, Eastman Kodak Co., Rochester, N.Y., "A Transmission Densitometer for Color Films."

Rowland L. Miller, Magnescope Corp., Culver City, Calif., "The Magnescope."

A. C. Robertson, Eastman Kodak Co., Rochester, N. Y., "Evaluation of 16 mm Professional Prints."

——————High-Speed Photography Session

Albert T. Ellis, California Institute of Technology, Hydrodynamics Laboratory, Pasadena, Calif., "A High-Speed Motion Picture System for the Photography of Small Nonluminous Subjects."

Everett J. Harrington and Harold C. Ramberg, Bonneville Power Administration, Portland, Oreg., "High-Speed Motion Picture Photography of Electrical Arcs on a High-Voltage Power System."

W. E. Martin, Consolidated Vultee Aircraft Corp., Daingerfield, Tex., "High-Intensity Light From A-C or D-C Operated Mercury Vapor Lamps."

Claude C. Baldridge and Lt. Gene C. Lemmon, Edwards Air Force Base, Edwards, Calif., "Applications of High-Speed Photography at Air Force Flight Test Center."

THURSDAY EVENING — Film Processing Session

John Fritzen, Cinecolor Corp., Burbank, Calif., "Processing 16 mm Color Film with a Silver Sound Track."

Howard T. Raffety, Cinecolor Corp., Burbank, Calif., "Matching Densitometry to Production."

W. T. Hanson, Jr., and W. I. Kisner, Eastman Kodak Co., Rochester, N.Y., "Improved Color Films for Motion Picture Production."

Allan M. Koerner, Eastman Kodak Co., Rochester, N.Y., "The Problems of Control of the Color Photographic Process."

Allan Haines and David P. Boyle, Pathe Laboratories, Hollywood, Calif., "Eastman Color Prints From Various Sources."

S. P. Solow and E. H. Reichard, Consolidated Film Industries, Hollywood, Calif., "A Modern Laboratory for 16 mm Film."

FRIDAY MORNING (Concurrent Sessions)
——————Sound Recording and Reproduction Session

Barry Eddy, University of California at Los Angeles, "Motion-Picture Sound Installation at the University of California at Los Angeles."

Murray Dichter and William H. Unger, Dichter Sound Studios, New York, "Push-Pull Negative Track Recording."

Kurt Singer and Michael Rettinger, RCA Victor Division, Hollywood, Calif., "Correction of Frequency-Response Variations Caused by Magnetic Head Wear."

J. E. Volkmann, J. F. Byrd and J. D. Phyfe, RCA Victor Division, Camden, N.J., "A New Theater Sound System for Multipurpose Use."

J. E. Volkmann, S. A. Caldwell and A. J. May, RCA Victor Division, Camden, N.J., "A Theater Loudspeaker System With Improved Directional Properties."

——————High-Speed Photography Session

Harold E. Edgerton and Kenneth J. Germeshausen, Edgerton, Germeshausen and Grier, Inc., Boston, Mass., "A Microsecond Still Camera."

John H. Waddell, Wollensak Optical Co., Rochester, N.Y., "A Full-Frame 35mm Fastax Camera."

Sidney M. Lipton, Aberdeen Proving Ground, Md., and Kennard R. Saffer, U.S. Naval Gun Factory, Washington, D.C., "The BRL-NGF Cinetheodolite."

Sidney M. Lipton, Aberdeen Proving Ground, Md., "A Multipurpose Optical Tracking and Recording Instrument."

Myron A. Bondelid, U.S. Naval Ordnance Test Station, Inyokern, China Lake, Calif., "The M-54 Tracking Mount."

FRIDAY AFTERNOON — Stereophonic Sound Session

John K. Hilliard (Committee Chairman), Altec Lansing Corp., Beverly Hills, Calif., "Sound Committee Report."

John K. Hilliard, Altec Lansing Corp., Beverly Hills, Calif., "Microphones, Loudspeakers and Amplifier for Use With Stereophonic Reproduction in the Theater."

Kurt Singer and Michael Rettinger, RCA Victor Division, Hollywood, Calif., "Multiple-Track Magnetic Heads."

John G. Frayne and E. W. Templin, Westrex Corp., Hollywood, Calif., "Westrex Stereophonic Recording and Reproducing Facilities."

R. J. Tinkham, Ampex Electric Co., Redwood City, Calif., "A Portable Stereophonic Recorder/Reproducer Utilizing a Sprocketless Drive Mechanism."

William H. Offenhauser, Jr., and Julius B. Postal, Andre Debrie of America, Inc., New York, and Calvin Hotchkiss, Eastman Kodak Co., New York, "Progress Report Interim Committee on Nomenclature."

FRIDAY EVENING — Wide-Screen Picture and Stereophonic Sound Session

Twentieth Century-Fox Film Corp., CinemaScope demonstration.

SATURDAY MORNING

Universal-International Pictures, Special showing for SMPTE members.

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High-Speed Photography, Volumes 1 and 2. Write Robert E. Hurley, American Newspaper Publishers Assn., 370 Lexington Ave., New York, N.Y.

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